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MOUNT RAINIER FOREST RESERVE, WASHINGTON

BY

FRED G. PLUMMER

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MOUNT RAINIER FOREST RESERVE, WASHINGTON.

By Fred G. Plummer.

BOUNDARIES.

By proclamation of the President made February 22, 1897, the Mount Rainier Forest Reserve was established with the following boundaries:

Beginning at the southeast corner of township four (4) north, range (9) east, Willamette base and meridian, Washington; thence northerly along the range line between ranges nine (9) and ten (10) east, subject to the proper offset on the first (1st) standard parallel north, to the northwest corner of township six (6) north, range ten (10) east; thence easterly along the township line to the northeast corner of said township; thence northerly along the range line to the northwest corner of township seven (7) north, range eleven (11) east; thence easterly along the township line between townships seven (7) and eight (8) north to the northeast corner of township seven (7) north, range twelve (12) east; thence northerly along the surveyed and unsurveyed range line between ranges twelve (12) and thirteen (13) east, subject to the proper offset on the second (2nd) standard parallel north, to the northwest corner of township eleven (11) north, range thirteen (13) east; thence easterly along the surveyed and unsurveyed township line between townships eleven (11) and twelve (12) north to the southwest corner of township twelve (12) north, range fifteen (15) east; thence northerly along the surveyed and unsurveyed range line between ranges fourteen (14) and fifteen (15) east, subject to the proper offsets on the third (3rd) and fourth (4th) standard parallels north, to the point for the northeast corner of township eighteen (18) north, range fourteen (14) east; thence westerly along the unsurveyed and surveyed township line between townships eighteen (18) and nineteen (19) north to the southwest corner of township nineteen (19) north, range seven (7) east; thence southerly along the surveyed and unsurveyed range line between ranges six (6) and seven (7) east, subject to the proper offsets on the township line between townships seventeen (17) and eighteen (18) north, and on the fourth (4th), third (3rd), and second (2nd) standard parallels north, to the point for the northeast corner of township five (5) north, range six (6) east; thence westerly along the unsurveyed township line between townships five (5) and six (6) north to the southeast corner of township six (6) north, range four (4) east; thence southerly along the unsurveyed range line between ranges four (4) and five (5) east, subject to the proper offset on the first (1st) standard parallel north to the point for the southwest corner of township four (4) north, range five (5) east; thence easterly along the unsurveyed and surveyed township line between townships three (3) and four (4) north to the southeast corner of township four (4) north, range nine (9) east, the place of beginning.

Excepting from the force and effect of this proclamation all lands which may have been prior to the date hereof embraced in any legal entry or covered by any lawful filing duly of record in the proper United States land office, or upon which any valid settlement has been made pursuant to law, and the statutory period within which to make entry or filing of record has not expired, and all mining claims duly located and held according to the laws of the United States and rules and regulations not in conflict therewith:

Provided, That this exception shall not continue to apply to any particular tract of land unless the entryman, settler, or claimant continues to comply with the law under which the entry, filing, settlement, or location was made.

GENERAL DESCRIPTION.

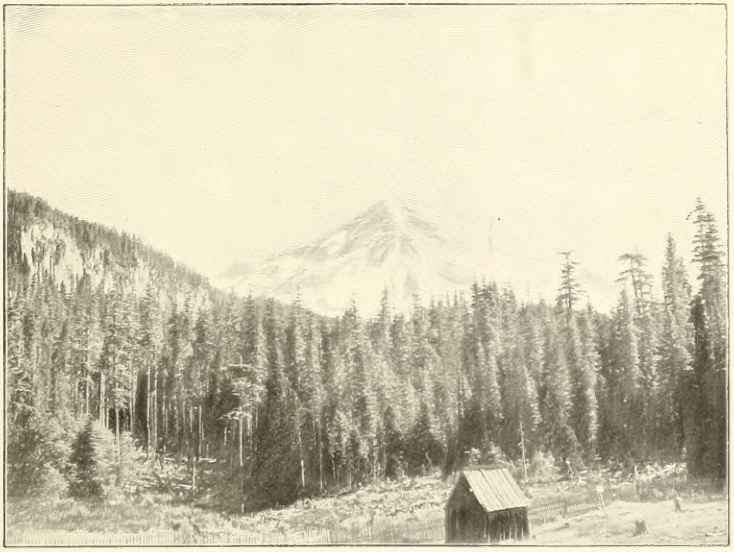
The tract thus reserved includes the Cascade Range in the southern part of Washington. The Government land surveys which partly bound and fix the location of the reserve have in western Washington been made from the Willamette meridian and in eastern Washington from the Columbia guide meridian. The sum of the discrepancies between them falls in the unsurveyed mountainous region partly covered by the reserve, and for this and other reasons the area of the reserve is 2,146,600 acres, and not 2,234,880 acres, as would be implied by the above description if all the townships were of full size. Of this total area 890,440 acres, or 41.4 per cent, lies on the eastern slope, and 1,256,160 acres, or 58.6 per cent, on the western slope of the mountains.

These two slopes, which will be often referred to in this report, present widely divergent conditions in climate and flora, but they share a bold topography in common. The line dividing these slopes, or the line separating the eastern drainage from the western, has a general direction of N. 5° E. Its detailed meanderings within the reserve are delineated on the map, Pl. XXXIII.

All of the eastern slope and the greater portion of the western drain into Columbia River, the tributary streams being the Cowlitz, Cispus, Lewis, Washougal, Rock, Wind, Little White Salmon, White Salmon, Klickitat, Atanum, Tieton, Naches, and Yakima rivers. The total watershed area of these streams is 1,794,600 acres, or 83.6 per cent of the reserve. The remainder, 352,000 acres, or 16.4 per cent, is drained into Puget Sound, the tributary streams being the White, Puyallup, and Nisqually rivers.

Within the reserve are four mountain peaks or domes of unusual magnitude: Mount Rainier, 14,526 feet; Mount Adams, 12,470 feet; Goat Mountain, 8,500 feet, and Mount Aix, 7,623 feet. Of these Mount Rainier and Mount Aix are not on the summit line, but like Mount St. Helens, Mount Stewart, and Mount Baker, all in Washington, stand on one side or the other of the range.

The glaciers and perpetual snow fields of Mount Rainier have a total area of 32,500 acres, and are therefore an important item in the estima-



A. MOUNT RAINIER AND LONGMIRE SPRINGS.

B. MOUNT RAINIER.

tion of areas without timber. The glaciers of Mount Adams cover only 2,300 acres, and those of Goat Mountain are insignificant. In unusual summer seasons, such as that of 1899, small areas of high altitude, protected from the warm chinook winds, may remain snow covered, but the perpetual snow fields and glaciers within the reserve are limited to Mount Rainier and Mount Adams. Probably an exceptionally warm season would leave no ice or snow on Goat Mountain.

The routes of travel in the reserve are few. Most of the trails shown upon the map are hardly deserving of the name, but indicate blazed lines where better progress can be made than by taking a course through the timber and brush. The Indian's policy was to go only where his pony could take him, and the idea of cutting and logging out a trail was repugnant to him; therefore his lines of travel were along the sparsely timbered ridges, where feed was generally plenty, where game abounded, or where huckleberries grew. Later came the prospectors and sheepmen, and in some places they did considerable work. Since the advent of settlers in the valleys of the Nisqually, Cowlitz, Wind, and Little White Salmon, wagon roads have been built and the larger streams bridged. Since 1896 stages have run from Tacoma to Longmires Springs during July, August, and September of each year to accommodate the tourist travel en route to Paradise Park. Twelve miles of this stage road is inside of the reserve and was constructed on a county survey prior to the proclamation of the reservation. Public sentiment strongly favors the opening of this scenic region by better lines of travel than the poor wagon road and pack trails. The Yellowstone and Yosemite will have a strong competitor when this is done. The setting aside of nine townships around Mount Rainier as a national park was an act which met with universal approval.

CLIMATE.

Accurate meteorological data are not obtainable regarding that portion of the Cascade Mountains within the boundaries of the reserve, as the Weather Bureau has never had an observer in that area. During the examination a large amount of fragmentary information was collected from settlers, prospectors, and trappers, and by personal observation. This has been used, with many interpolations, in the preparation of the accompanying maps.

The bold topography of the reserve is the cause of wide diversities in climatic conditions, some of which are general and affect large areas, while others affect only small areas. The rain-bearing clouds are brought by southwest winds from the Pacific Ocean, and find easy access to the Cascade Range through breaks in the Coast Range. The mountains along the coast, owing to their position and height, are great rain producers for their own areas, but the range is not

continuous and the gaps in it are low. Important among the gaps, as affecting the region under consideration, are those made by Grays Harbor, Willipa Bay, Columbia River, Tillamook Bay, and Yaquina Bay.

The Cascade Range, running north and south, parallel with the coast, presents a more continuous barrier to the rain-bearing clouds, the only break or gap being that through which Columbia River flows.

The winters in the mountains are long rather than severe. Doubtless upon such elevations as Mount Rainier, Mount Adams, or Goat Mountain the prevailing conditions during the winter are of extreme severity.

A strong contrast is presented between the corn and tobacco fields of the Cowlitz Valley and the ice fields and glaciers of Mount Rainier, and yet among these same glaciers in the mountain parks a profusion of wild flowers and grasses results from the mild and delightful climate that prevails during the short summer season. It is always a matter of surprise to the tourists that they may camp in summer gardens surrounded by arctic scenery on such a grand scale, but this camping season is limited to July, August, and September.

During 1886, 1887, and 1888 the engineer department of the Northern Pacific Railway kept a weather record at Stampede Pass tunnel, and from those observations the following table has been compiled:

Average temperature and snowfall at Stampede Tunnel, Washington, for 1886–1888.

[Altitude, 2,840 feet.]

Months.	Greatest depth of snow.	Temperature.	
		Highest.	Lowest.
	Feet.	*Degrees.*	*Degrees.*
January	8.9	42	10
February	7.5	47	16
March	7.5	55	20
April	5.5	61	41
May	2.6	77	35
June	.....	72	43
July	.....	86	48
August	.....	82	51
September	.....	76	40
October	.2	62	32
November	1.1	50	19
December	3.6	42	18

A NARADA FALLS, PARADISE PARK.

B ICE CAVES.

ARABLE LANDS AND SOIL FORMATIONS.

Only about 45,000 acres or 2 per cent of the entire reserve is fair farming land, and of this amount more than one-half is under adverse climatic conditions due to great altitude and exposure.

Of the favorably situated areas in western Washington the most important is the Cowlitz watershed.

The Cowlitz Valley widens for a length of 13 miles within the reserve and includes some very good land known as the "Big Bottom," which contains about 12,000 acres, of which 25 per cent is slashed and partly cleared. The soil formation, as shown by the wells and river banks, averages as follows:

Section in Cowlitz Valley, Washington.

	Feet.
Sand or sandy loam	1.0
Scoria sand	.5
Sand and sandy loam	12.0
Gravel and sand	4.0
Scoria sand	2.0
Clay and sand.	

Bear Prairie, in sec. 8, T. 14 N., R. 8 E., at the head of Snake Creek, in the same watershed, contains about 90 acres of good hay land and has been drained by the claimant. The formation as shown by the ditching is as follows:

Section in sec. 8, T. 14 N., R. 8 E., Washington.

	Feet.
Sandy loam	1.0
Scoria sand	.1
Sandy loam	1.25
Scoria sand	1.0
Sandy loam.	

The Nisqually below the mouth of Horse Creek has an area of about 4,000 acres, of which 30 per cent is a liberal estimate of the arable portions. The balance of the bottom lands are either rocky, gravel, or clear-washed sands, with little soil or humus. The areas which are arable are covered with thick stands of forest and it costs $100 to $150 per acre to prepare them for the plow. The settlers on these lands often leave the stumps in their fields and garden patches.

On the South Fork of Puyallup River, on which no settlement has been made, there are about 300 acres of arable land in scattered patches which would be difficult to clear.

The Mowich River bottom inside the reserve has about 1,000 acres of very fair land which is heavily timbered.

The Carbon River Canyon is uninviting to the farmers. The steep side hills run almost to the river and a few little patches of good soil are all that can be mentioned. The same is true of the White River Canyon.

In the valley of Cispus River, below the mouth of Anatass Creek, there are about 1,000 acres of arable bottom and bench lands in scattered tracts. The same scoria sand found in the Cowlitz and other watersheds is present. In sec. 2, T. 11 N., R. 7 E., a well 5 feet deep in a swale showed the following:

Section in sec. 2, T. 11 N., R. 7 E.

	Feet.
Scoria sand	1
Black muck	4
Coarse sand.	

The valley of the Lewis River within the reserve is a canyon at its lower end, and those areas nearer the headwaters are of too great altitude to be of any use.

Wind River Valley is low and broad and contains about 8,000 acres of good land but difficult to clear. Being easily accessible from Columbia River, this area has found many settlers.

The same is true of the valley of the Little White Salmon River, which contains about 2,000 acres. The timber is smaller and has been partly removed by logging and railroad-tie cutting. In the White Salmon River Valley about 2,000 acres might be made profitable by irrigation, but the season would be short.

In the Klickitat watershed lying between the Fish Lake Stream and the Clearwater is about 2,500 acres of moist bench land. It would cost $75 per acre to prepare it for the plow, and by reason of the severe winters and short summers it would be of doubtful value. Bordering the Klickitat and the Lower Fish Lake Stream in Ts. 8 and 9 N., R. 12 E., there is an area of about 10,000 acres of bench land supporting a growth of yellow pine (*Pinus ponderosa*) and pine grass (*Calamagrostis suksdorfii*). When cleared it would be fair land under irrigation.

On the headwaters of the main Klickitat River are a series of meadows which will aggregate about 800 acres. The level bottom and low benches of fair land bordering these meadows may be classed as arable land and will add 1,200 acres to the above, making a total of 2,000 acres. These bottoms are divided transversely by several low ridges both in appearance and formation strongly suggestive of terminal moraines of an ancient glacier. No striæ were noted.

Conrad Meadows, on the South Fork of Tieton River, contain about 100 acres which should be drained.

At the head of Tannum Lake on Bumping River is about 500 acres of bottom land with a growth of young fir, hemlock, cedar, and light underbrush. Small areas of this bottom are timberless and grassed.

Other small and unimportant areas of arable land are Goose Prairie on Bumping River and Pleasant Valley on American River, and also a few benches and small lake beds on the Naches and Tieton rivers.

A. TATOOSH RANGE; MOUNT ST. HELENS IN DISTANCE.

B. SMALL LAKE NEAR INDIAN RACE TRACK; SECOND GROWTH OF MOUNTAIN FIR AND HEMLOCK.

Near the headwaters of many of the smaller streams are small meadows, but their elevation and exposure forbid their use for agricultural purposes.

The surface soils other than above detailed are entitled to only brief mention. The bold topography of the area prohibits the accumulation of deep or rich soils. The underlying ledges, talus, and gravels are covered with sand, resulting from decomposition, and over many areas with scoria. This scoria is both of interest and value. Some samples were taken from an undisturbed bank on a hill in the SE. ¼ of SE. ¼ of sec. 18, T. 12 N., R. 7 E., and gave a weight of 49.55 pounds avoirdupois per cubic foot. After being screened a cubic foot of the sand, whose grains ranged in size from one-half to one-eighth inch in diameter, weighed 43 pounds. The same screening after being dried weighed 37.4 pounds.

This sand follows the surface of the country, and in the higher elevations is often exposed, and over small areas has been recently eroded. Its color is a dull straw, sometimes deep brown. It is very coarse, gritty, and free from loam and other foreign matters, and is never waterworn. It is always loose, never compact. When exposed to air by the plow it undergoes a slow slaking process, and is regarded as remarkably fertile soil. In Cowlitz Valley John Blankenship says his field of sand changed very much by working, as it decomposed, turned yellow, and made good soil, which he has used for growing artichokes. His flower garden blooms freely, but the plants are not thrifty. Scoria sand taken from his well was thrown over the surface of the ground, and showed its fertility by the growth of weeds which followed.

All of the evidence presented by the scoria sand points to the probability of its being the result of a recent volcanic eruption, but to name the volcano or to fix the date will require more extended examination.

COAL INDICATIONS.

The Columbia River lava (Miocene) has overcapped and almost completely buried the coal-bearing strata (Eocene) within the reserve. Rarely has erosion uncovered the upper measures, which are found badly faulted and broken, and in several cases metamorphosed by heat.

Eocene sandstone and fossil-bearing shales were recognized near the southwest corner of sec. 18, T. 17 N., R. 8 E.; also on Goat Creek, Coal Creek, and Sweetwater Creek on the Nisqually watershed. The fossils are the leaves of alders, maple, and willow and resemble those found in the roof rocks of the Roslyn coal mine in eastern Washington and in other coal mines on the west side of the range. Coal float was found at these localities. Fossil leaves are also reported from the Wind River watershed, near Lookout Mountain.

The Davis coal prospect on Summit Creek has been worked to a small extent to determine its value. A vein 6 feet wide is claimed, which crosses Summit Creek, and is exposed on both sides of the canyon. The improvements consist of two small cabins, a shaft about 10 feet deep, and two tunnels.

Coal veins exist in secs. 13 and 14, T. 12 N., R. 8 E., and some prospecting has been done, but the work has been abandoned. Two miles north of Packwood Lake several small coal veins have been prospected.

On the headwaters of Cispus River, in T. 10 N., R. 10 E., several coal veins have been prospected, but no real development work has been done. Traces of coal have been found underlying the basalt at Steamboat Mountain.

MINERALS AND MINING CLAIMS.

The Columbia River lava is not a favorable formation for the deposition of the precious metals in paying quantities, although waters slightly charged with minerals have deposited gold, silver, lead, iron, and silica along cleavage planes in the high country rock, which is mainly diabase capped with lava. On the surface where these infiltrations occur the original sulphide deposit has been oxidized and concentrated, so that by panning some color of flour gold can be obtained. Below the line of oxidation, at a depth of about 30 feet, the mineral deposit changes to low-grade iron pyrites, which requires smelting and is not of sufficient value to make it profitable to mine.

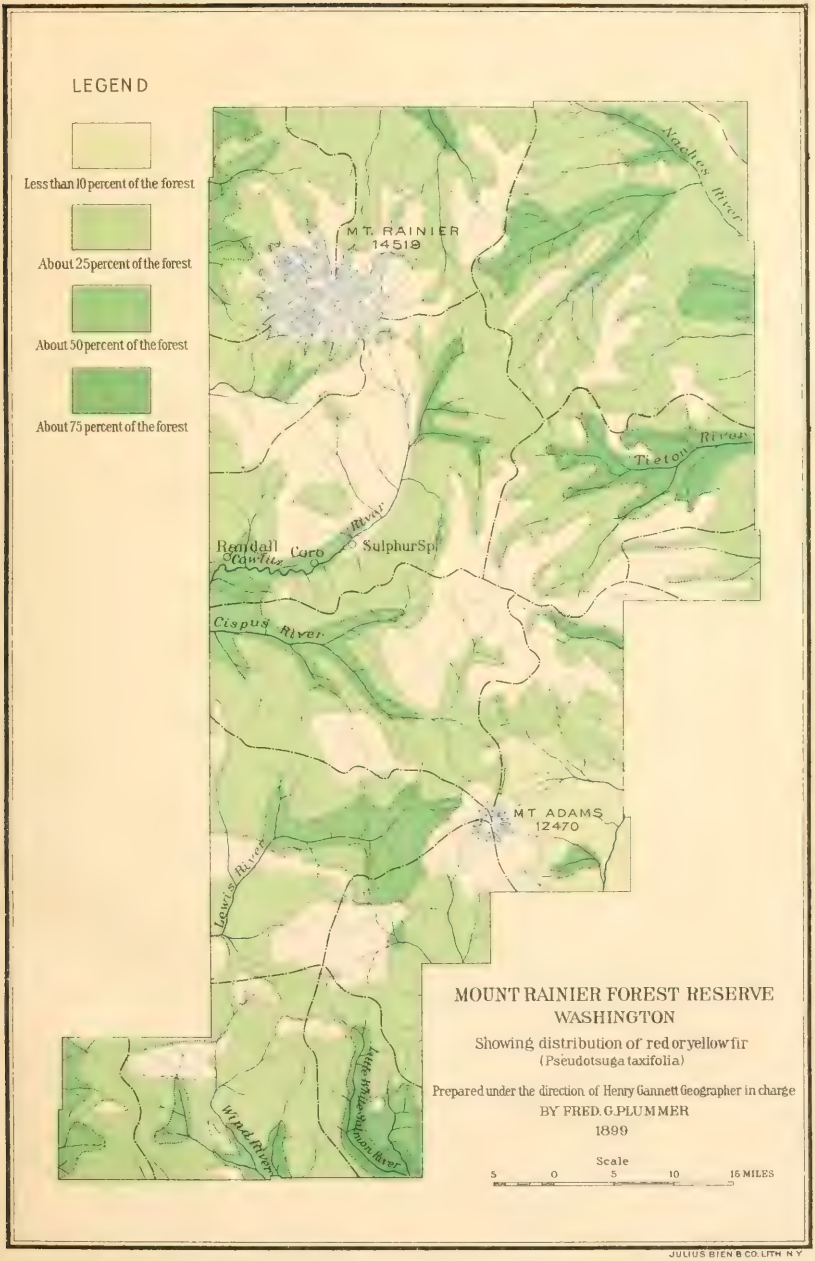
These veins do not show any characteristics of true fissure or contact fissure veins, there being no ribbon structure of the vein matter or striation of the walls, but merely an impregnation of the country rocks, which would indicate that they are merely gash veins which will in all probability terminate at a slight depth.

The placer ground on Moore Creek, at the base of Gold Hill, is said to give colors to every pan, but inasmuch as several parties have operated it in years past and have given it up it can not be very profitable.

The Medina Mining Company is building a 5 stamp mill on the west side of Silver Creek to test the free or oxidized ore. On the opposite side of the gulch the Florence Company is running a crosscut tunnel easterly in diabase rock for the purpose of tapping some ore veins that crop on the slope of the mountain above. If the company is successful in this it may prove that the veins at this point have depth and are not gash veins in the cleavage of the country rock.

MINERAL SPRINGS.

James Longmire patented 20 acres of land lying in secs. 29 and 32, T. 15 N., R. 8 E., as a mineral claim. He erected an inn, barn, two bath houses, one storehouse, and two small shacks.



JULIUS BIEN & CO. LITH. N.Y.

Within the limits of this claim are about twenty mineral springs having temperatures from 50° to 90° F. A sample of one of the springs was sent to G. A. Mariner, of Chicago, for analysis, who reported as follows:

Analysis of water from secs. 29 and 32, T. 15 N., R. 8 E.

[Analyst: G. A. Mariner.]

	Grams.
Silica	0.080410
Calcium carbonate	1.077200
Magnesium carbonate	.617780
Iron oxide	.000580
Sodium sulphate	.030251
Sodium chloride	1.463600
Potassium chloride	Trace.
Sodium carbonate	.063195
Sodium silicate	.062326
Hydrogen sulphide	Trace.
Total solids in one liter	3.515262

These springs are steady in their flow and have shown no signs of failing.

On the north side of Summit Creek in the Cowlitz watershed is a mineral spring claimed by David Longmire. It was located September 5, 1897, as a red mineral paint spring claim. The spring is 4 feet in diameter and is 100 feet from Summit Creek. The amount of flow is about 1 cubic foot per minute. It tastes like soda water strongly impregnated with iron. The temperature is about 40° and the water is very refreshing. The pack animals drank it with relish.

A similar spring is reported on the right bank of Bumping River, 5 miles below Tannum Lake.

A mineral spring is located on the north side of Cowlitz River in sec. 32, T. 13 N., R. 9 E. The waters issue from several fissures of the rock in place and flow into the river, which is only 10 feet distant. The spring is below the level of high water, and its waters are strongly impregnated with sulphur and iron, and have a temperature of about 100° F.

In sec. 34, T. 14 N., R. 14 E., on the south side of Tieton River, are mineral springs having a flow of about 0.25 cubic foot per minute. One has a temperature of 105° F. The others are cold.

The Klickitat soda springs in the north half of sec. 23, T. 11 N., R. 12 E., are probably the finest soda springs in the reserve, although they have not so great a flow as the Longmire Springs, nor are they as well situated for use. The main spring issues from a rock crevice on the south side of Klickitat River, below the high-water line. To make the water accessible the stock herders have built a wing dam which exposes the bubbling spring. Its flow is about 1 cubic foot per

minute, and is steady. The water is clear and sparkling, with an agreeable taste resembling vichy. It is a strong appetizer, and acts quickly and vigorously upon the kidneys.

On the north side of the river, and just above high-water mark, are two barely perceptible springs, one warm and the other cold. Two other springs issue in the bed of the stream, and can be located by the bubbles of gas which rise to the surface.

In sec. 36, T. 9 N., R. 12 E., is a fine soda spring, which has long been known and used by the Indians. Its waters are clear and cold and carry iron, as is shown by the red formation about it. Its flow is 0.25 cubic foot per minute. Near this spring are three yellow pines (*Pinus ponderosa*) of less than 18 inches diameter, which have been affected by the spring. Their foliage is of a light-brown color, is very scanty, and droops.

Numerous small soda and iron springs are found along the Clearwater Fork of the Klickitat River in the box canyons.

EVIDENCES OF RECENT VOLCANIC ACTIVITY.

On the slopes of Mount Adams are many evidences of recent volcanic activity, and important among these are cinder cones and bombs.

The cinder cones are miniature volcanoes in form. One, situated about 3 miles northeast of the summit of Mount Adams, at an elevation of 7,000 feet, is worthy of special mention. Its height is about 500 feet and the crater at its summit has a diameter of 175 feet and a depth of 75 feet. The cinders which form its mass and the flora growing upon it are unique and interesting.

The lava, scoria, and pumice are often of brilliant colors—red, orange, and yellow predominating. Some of the pumice is of finer texture than that in use commercially, and the volcanic glass is found in all shades, from black to clear, transparent globules.

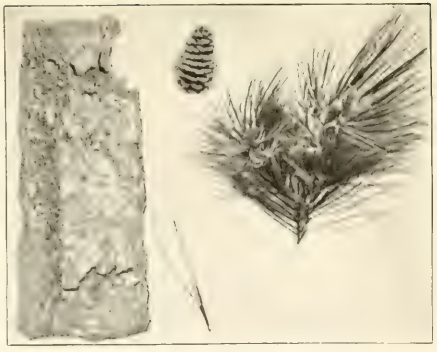
On the northern side of Goat Peak an area of over 1,000 acres is completely covered with scoria and cinders, and this area is timberless. If a crater exists it was covered with snow at the time of the examination.

The bombs found on the lower slopes of Mount Adams are spherical masses of homogenous lava, and lie in piles upon the former lava flows. They are of all sizes up to 20 feet in diameter, and in every case have been fractured and their hard, glassy formation exposed. Frequently the fracture planes show a rind of several inches depth from the original spherical surface toward the center.

CAVES.

At the headwaters of the White Salmon and Little White Salmon rivers are large areas of partly exposed lava beds. Where a soil has formed it appears to be good, but of no depth, and the timber which it

A. TSUGA PATTONIANA.



B. PINUS PONDEROSA.

C. PINUS MONTICOLA.

D PSEUDOTSUGA TAXIFOLIA.

supports is scrubby and of small size. A line of caves may be traced along this formation for a distance of 10 miles inside of the reserve and as far again outside. In some cases the caverns appear to exist by reason of the sinking of the flooring, which is of basalt, but quite as frequently they take the form of gigantic bubbles, the roof stratum being buckled up and broken, permitting an entrance to the interior.

Often these caverns are continuous for a considerable distance underground, the passages widening in the vicinity of the surface opening. In one of these caves, situated in sec. 25, T. 6 N., R. 9 E., ice remains during the entire year, and it has merited the local name of the "Ice Cave." It is about 350 feet in length, with a maximum height of 10 feet and extreme width of 60 feet.

The ice is in the form of stalactites and stalagmites; in some cases joined into pillars 3 feet thick. It has been a custom of visitors to build fires in the caves, and much of the natural beauty of this cave has been destroyed. The practice of wantonly breaking the ice formations has also contributed to the destruction of its beauty.

A small cave was found on the southeast slope of Mount Adams, near Hell Roaring River. Deep water prevented its exploration.

MOUNTAIN PARKS.

All the divides become beautiful parks as they approach the slopes of Mount Rainier. In place of the close stand of forest which characterizes the lower slopes, the mountain firs and hemlocks are grouped upon the lesser ridges and hummocks from which the snow first disappears in the spring. At least 80 per cent of the areas above 5,000 feet and below the timber line may be classed as mountain meadows. They are plentifully watered by little streams and lakes and the soil supports a heavy growth of wild flowers, ferns, and juniper. The limit of perpetual snow extending through some of these parks gives opportunities for coasting and snowballing, which are enjoyed by the many campers who make these grounds their summer resort. Parks which are well known because of their beauty and accessibility are Paradise Park, Magnetic Park, and Indian Henry's Ground, on the southern slope of the mountain, Spray Park on the northwest slope, Moraine Park and the Elysian Fields on the northern slope.

The summit of the Cascade Mountains and the high spurs that extend from it are generally a succession of parks, plentifully grassed and flowered. On the eastern slope these areas have been considerably used for pasturing sheep, and much of their natural beauty destroyed, but only in the regions of the burns do any of the grander vistas bear witness to the carelessness or greed of man.

TREE SPECIES.

The coniferous trees of the reserve are as follows:

Coniferous trees of Mount Rainier Forest Reserve, Washington.

Pinus monticola Dougl	White pine.
Pinus ponderosa Laws	Yellow pine.
Pinus murrayana Oreg. Com	Lodgepole pine.
Pinus albicaulis Engelm	Mountain pine (white-bark).
Abies nobilis Lindl	Noble fir (larch).
Abies amabilis (Loud.) Forb	Lovely fir (larch).
Abies concolor (Gord.) Parry	White fir.
Abies lasiocarpa (Hook.) Nutt	Alpine fir (subalpina).
Tsuga mertensiana (Bong.) Carr	Hemlock.
Tsuga pattoniana Engelm	Mountain hemlock.
Picea engelmanni (Jeffr.) Engelm	Engelmann spruce.
Picea sitchensis (Bong) T. and M	Tideland spruce.
Pseudotsuga taxifolia Poir	Red and yellow fir (hemlock spruce).
Thuja plicata Don	Red cedar.
Chamæcyparis nootkatensis (Lamb.) Spach.	Alaska cedar.
Larix occidentalis Nutt	Tamarack.
Taxus brevifolia Nutt	Yew.

The large deciduous trees are as follows:

Deciduous trees of the Mount Rainier Forest Reserve, Washington.

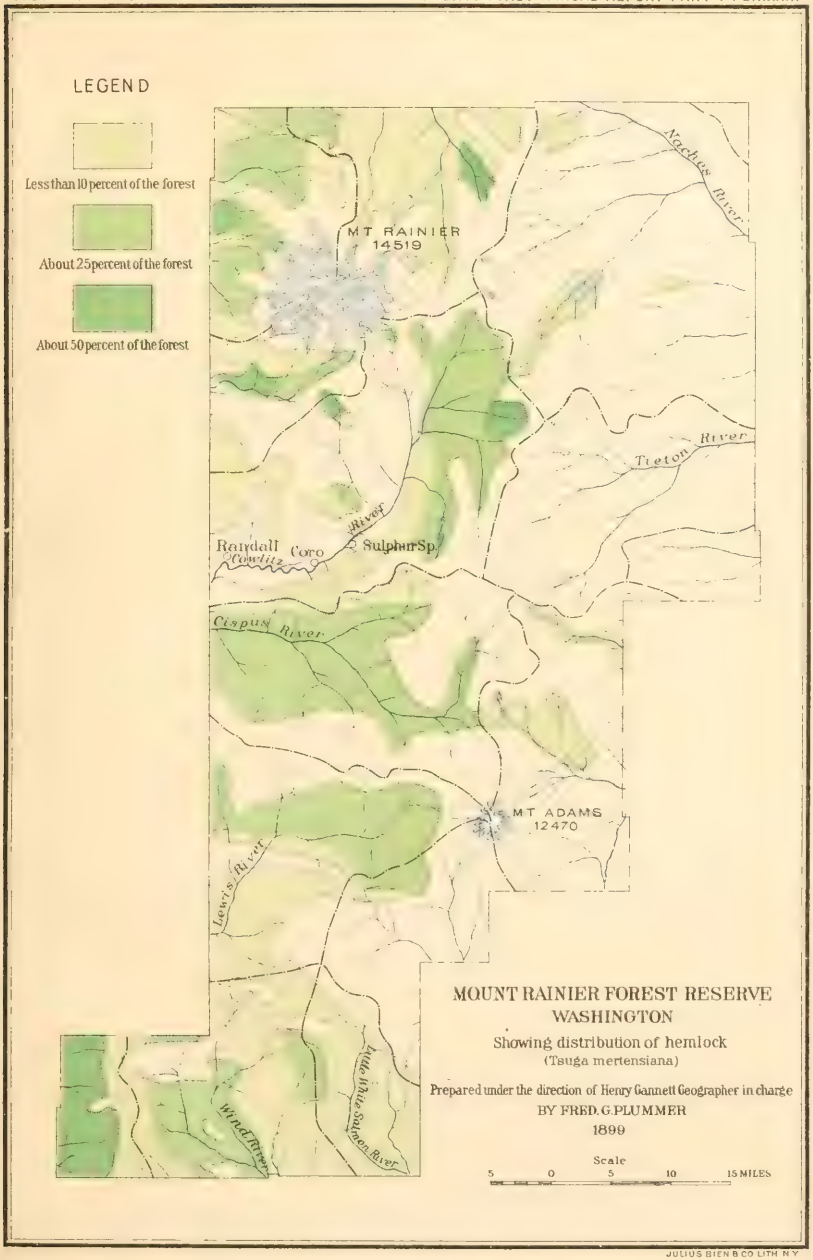
Fraxinus oregona Nutt	Ash.
Acer macrophyllum Pursh	Maple.
Populus trichocarpa Torr. and Gr	Cottonwood.
Populus tremuloides Michx	Quaking aspen.
Quercus garryana Dougl	Oak.

Small deciduous trees of no value as timber are included in the list of underbrush.

In the descriptions which follow, the order of arrangement is the same as given above, the trees of each genus being together without regard to commercial rank.

PINUS MONTICOLA Dougl. (White pine).

This species is found from sea level to an elevation of 6,000 feet. The greatest diameter is 5 feet and the extreme height of individuals observed was 150 feet. About two-thirds of the height is crown. The heartwood is white and the sapwood light yellow. The wood is light, soft, not very strong, but quite durable. It reaches its greatest development at an elevation of 3,500 feet, and in comparison with the other pines occupies a middle zone, being above the yellow pine (*P. ponderosa*) and below the lodgepole and mountain pines (*P. murrayana* and *P. albicaulis*). Although not as strong as the yellow pine, the



MOUNT RAINIER FOREST RESERVE
WASHINGTON

Showing distribution of hemlock
(Tsuga mertensiana)

Prepared under the direction of Henry Gannett Geographer in charge
BY FRED. G. PLUMMER
1899

Scale
5 0 5 10 15 MILES

JULIUS BIEN & CO. LITH. N.Y.

absence of pitch and more even texture makes it the most valuable of the pines found in the State of Washington. The typical tree is erect and graceful, with lighter and more delicate foliage than other pines. It is found on both sides of the Cascade Range, but attains its best development on the moist hillsides and benches of the eastern slopes. It does not form a forest of pure growth, being always associated with one or more species of fir or with the red cedar (*Thuja plicata*).

Pinus ponderosa Laws. (Yellow pine).

This species has a range of from 400 to 6,200 feet in altitude. The extreme diameter noted was 6 feet, with a height of 200 feet. The heartwood is yellow and the sapwood is white and resinous. The wood is heavier than that of the white pine and stronger, though rather brittle and not very durable when exposed to moisture. Among the pines it occupies the lowest altitudinal zone, reaching its maximum development at an elevation of 2,500 feet, and by reason of its greater accessibility and distribution it is commercially the first in use. The inferior trees are called bull pines, and with many lumbermen a distinction is made, dependent upon the amount of sapwood in the log.

The yellow pine forms an open forest of pure growth at the lower timber line in eastern Washington bordering the arid region, for the reason that it leads the other conifers in the spreading of the timber. Its ability to grow on worthless rocky soil, on the face of cliffs, or on the talus is marvelous. It is a necessary agent to promote the accumulation of soil and humus for the conifers of greater commercial value which follow its lead.

The yellow pine is not strictly an eastern Washington tree, as it occupies many small and scattered areas on the western prairies near Roy, but these areas are insignificant in comparison with its universal occurrence in the lower timbered areas east of the mountains.

At its highest altitudinal limit the yellow pine, although dwarfed in height, attains large diameter of trunk and appears strong and thrifty. The crown is low and the main branches abnormally heavy and without the symmetry of the typical forest tree at lower altitudes.

Pinus murrayana Oreg. Com. (Lodgepole pine).

The extreme range of this species is from 1,800 to 7,100 feet in altitude, but its growth above 5,000 feet is very scattered, and it is only the presence of a few individuals that puts the upper limit at 7,100 feet. It attains a height of 80 feet and a diameter of 26 inches rarely. The heartwood is creamy, white, or pink, and the sapwood slightly whiter. The timber being generally small and of poor quality, it is chiefly used for fence rails and firewood. At an altitude of 4,000 feet it attains its maximum growth, and on some of the dry river benches forms pure

forests over small areas. Even at maturity the crown covers three-fourths or seven-eighths of the height. *Pinus contorta*, also called "black pine," has a lower range to sea level, but was not positively determined within the boundaries of the reserve.

PINUS ALBICAULIS Engelm. (Mountain pine).

This species of pine is only found on the higher elevations, and has a range from 5,000 to 8,200 feet. It is the only tree found above 7,500 feet. Its extreme height is 50 feet, with a diameter of 26 inches. According to its exposure, it may be three-fourths crown or with only a very scanty foliage on the lee side near the top. The heartwood and sapwood are light straw color. The wood is hard and tough, and splits with difficulty.

It sets cones in abundance at an altitude of 7,000 feet, where it often comprises 90 per cent of the trees. Its associates at this altitude are *Abies lasiocarpa*, *Tsuga pattoniana*, and *Chamæcyparis nootkatensis*, all of which have reached their growth at lower elevations. The seeds are edible, and the trees are sometimes cut down to secure them. On one ridge of Mount Adams about 100 trees were felled for this purpose.

At and near its higher altitudinal limit it is a mere shrub, finding shelter behind larger rocks or crags. The foliage is often thickly matted, and in its procumbent form hides the gnarled trunk, which is of monstrous size in comparison with its crown.

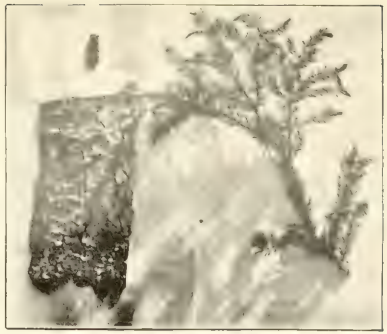
ABIES NOBILIS Lindl. (Noble fir).

This is the finest timber tree in the forests of the reserve, and is found between altitudes of 1,800 and 5,200 feet. The diameter of the largest individual found was 6 feet, with a height of 225 feet. In the forest the crown extends only one-third of the height, and the trunk is generally a perfect cylinder, standing perpendicular. The heartwood and sapwood are light straw color, light, hard, strong, and elastic, and quite free of resin. The elevation at which it flourishes best is 3,000 feet, but with the lovely fir (*Abies amabilis*) it often forms dense forests at 3,500 and even 4,000 feet.

ABIES AMABILIS (Loud.) Forb. (Lovely fir).

This species is found between altitudes of 800 and 5,500 feet. The trees attain a height of 200 feet, with a diameter of 5 feet, of which one-third to one-half is crown in the forest growth. In the open it often has branches to the ground. The heartwood and sapwood are light straw color, the heartwood being slightly darker. The wood is not hard nor very strong, and splits easily between knots.

A. ABIES CONCOLOR.



B. PICEA ENGELMANNI.

C. ABIES LASIOCARPA.

D. PINUS ALBICAULIS

The wood of this fir is very little known commercially in Washington, but has been cut and sold with the noble fir under the name of larch. Its wood is better than that of the white fir (*Abies concolor*), with which the tree is sometimes confounded, but will not rank with that of the noble fir. It has been used in the manufacture of excelsior.

ABIES CONCOLOR (Gord.) Parry (White fir).

This fir has an altitudinal range from sea level to 4,200 feet. The extreme diameter noted was 3.5 feet, with a height of 150 feet, of which two-thirds was crown. The heartwood is white and the sapwood a creamy color. The timber is not heavy, hard, nor strong, but is rather brittle, and perishable when exposed to alternate moisture and dryness. There is a prejudice against the wood, as it compares poorly with the species now being logged for building timber. It has been used for inside finishing, and from the larger trees fine shingles can be made.

ABIES LASIOCARPA (Hook.) Nutt. (Alpine fir).

This beautiful fir has an altitudinal range from 4,000 to 7,500 feet. The greatest diameter is 2 feet and height 80 feet, of which nine-tenths is crown. Heartwood is a creamy color and the sapwood is white. The wood is not very heavy, hard, nor strong, but is elastic and durable when seasoned. It is almost always associated with Patton's hemlock in the higher altitudes. The typical tree is an acute cone extending almost to the ground in strong and vigorous branches. The base of the cone is about one-fifth of the height. The trunk is generally straight, and, by observation of the young trees, is generally scrubby, knotted, and twisted, and much dwarfed in growth. At the timber limit of 7,500 feet it is procumbent and attains the form of grotesque bushes and shrubs. In the lower valleys where this species is found there is sometimes 30 feet of clear trunk, above which the branches droop in graceful curves. The wood splits straight, but with difficulty between the knots, which run to the center of the tree.

This tree is not known to the local lumbermen, and owing to its small size and lack of clear trunk is of little or no commercial value.

TSUGA MERTENSIANA (Bong.) Carr. (Hemlock).

This tree is found from sea level to an altitude of 5,000 feet. Extreme diameter is 6 feet, with a height of 250 feet, of which one-half to two-thirds is crown. The heartwood is grayish white, and the sapwood is cream color. It is not very heavy, but is hard and quite strong. It is more brittle than fir, although not so durable, and the knots run to the center of the tree.

It sometimes forms a forest of pure growth, but in this case the timber is generally very tall and slender, and only suitable for piles. Although in Washington it ranks next to fir in quantity, it is generally considered an inferior wood, and has been logged very little in this State, except in localities where the fir has become scarce. Time will probably overcome the prejudice to the hemlock timber, as it makes very good floors and ceilings and has a very good surface under the plane. It does not splinter like the eastern hemlock, and takes stain and oil easily. The bark of this hemlock is useful for tanning, and the preparation of tanning extract is an industry at Clallam Bay and South Bend. The bark, being very rich in tannic acid, makes a very superior extract. Owing to the limited market on the Pacific coast and the cost of sending the product East to compete with other extracts in a falling market, incident to the panic of 1893, it was found that it could not be manufactured at a profit at South Bend.

Tsuga pattoniana Engelm. (Mountain hemlock).

This hemlock is found from an altitude of 3,500 to 7,500 feet. The largest diameter is 3 feet, and height 125 feet, four-fifths of which is crown. The wood is yellow, hard, and somewhat brittle. It sometimes forms a forest of pure growth over limited areas, but is generally found associated with *A. lasiocarpa* and *P. albicaulis*. The largest and heaviest stands of these hemlocks were found at an elevation of 6,000 feet near Jennies Peak, but the clear trunks were seldom over 40 feet.

Picea engelmanni Engelm. (Engelmann spruce).

This spruce has an altitudinal range from 1,000 to 6,200 feet. The greatest diameter is 3.5 feet, with a height of 150 feet, of which one-half to two-thirds is crown in the forest trees. Mature trees growing in the open generally have a symmetrical cone-shaped crown to the base. The heartwood and sapwood are white, soft, light, and not very strong. It has even grain and splits easily and, being without pitch or disagreeable odor, is a very valuable wood commercially, particularly for cooperage and fruit boxing.

No forest of pure growth was found. The best growth is upon the lower mountain slopes and benches, where it is associated with pines, firs, and tamarack.

Picea sitchensis (Bong.) T. and M. (Tide-land spruce).

This species is found from sea level up to an elevation of 1,800 feet within the boundaries of the reserve, west of the Cascade Mountains. It sometimes reaches a diameter of 5 feet and a height of 175 feet, of which two-thirds would be crown. The wood is white, light, medium

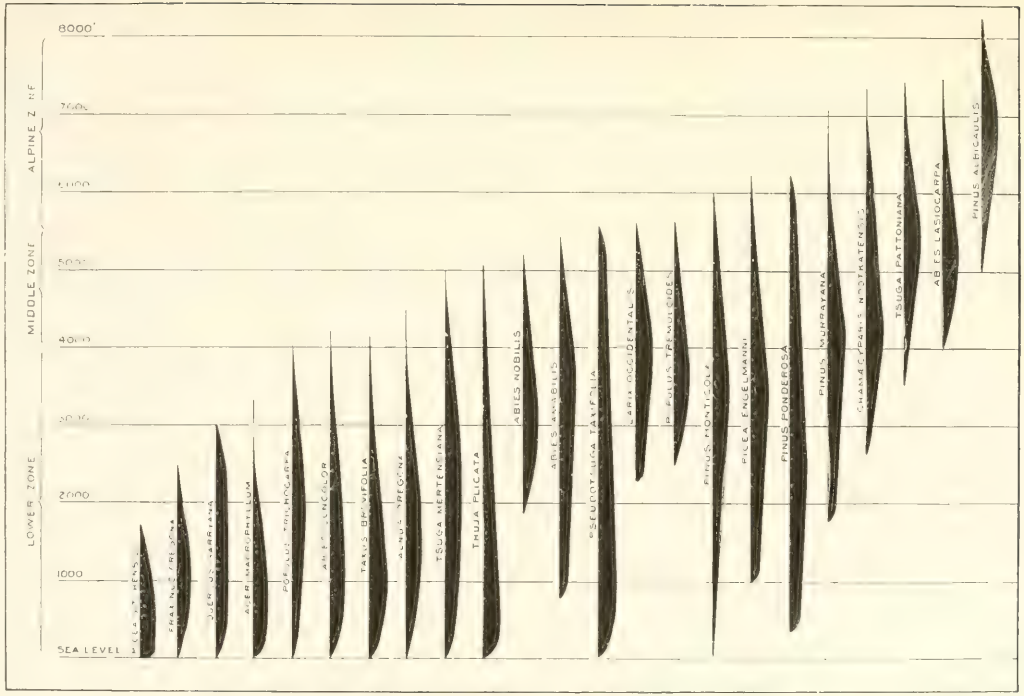


DIAGRAM SHOWING RANGE [illegible] TIMBER TREE [illegible]

hard, and strong, and is brittle when green, but quite durable and splits easily. This spruce was positively determined only at one point in the reserve—namely, in the Nisqually Valley, near the west boundary—and it was from this that the upper limit of 1,800 feet was fixed. As its name indicates, its habitat is at lower elevations than those of the reserve.

PSEUDOTSUGA TAXIFOLIA Poir. (Yellow and red fir).

There are two varieties of this species which are not distinct botanically, although the difference is recognized by loggers and mill men throughout the State. The yellow fir grows from sea level to an altitude of 5,600 feet, and reaches an extreme diameter of 13 feet and a height of 300 feet, of which two-thirds is crown. The bark is very thick and deeply fissured. The thickest specimen of bark found measured 22 inches on the radial line. The heartwood is yellow and the sapwood is white, quite heavy, hard, elastic, durable, and splits easily. The red fir, which grows to about the same altitude, does not exceed 7 feet in diameter and 225 feet in height, of which two-thirds is crown. The heartwood is salmon-red color and the sapwood is white or cream color. It is slightly heavier than the yellow fir, more resinous, and not so strong or elastic. When seen in the forest the red fir differs by having a thin bark of a lighter color, and in general does not present as rugged an appearance as the yellow fir. However, many specimens were found which were difficult to determine, and in individual trees it would not be easy to tell the difference between a thin-barked yellow fir and a heavy-barked red fir. Many of the larger trees having a diameter of from 6 to 9 feet are in process of decay, being from 500 to 800 years old. The bark is scaly and loose from the trunk at the butt, and the tops are dead. In estimating the amount of timber per acre a due allowance was made for the above fact. This timber ranks first in commercial value among the timbers of this State by reason of its superior strength, wide distribution, and accessibility.

In the Cowlitz Bottom a fallen fir tree was examined and found to be perfectly sound (excepting 2 inches of the exposed surface), although it had laid upon the ground for seventy-eight years, as testified by the age of a cedar tree which had grown over and straddled it.

THUJA PLICATA Don. (Red cedar).

This tree, which is also known as arbor vitæ, has a range from sea level to 5,100 feet. The extreme diameter breast high was found to be 12 feet with a height of 175 feet, of which three-fifths is crown. The heartwood is very light brown and the sapwood generally white. It is very light, soft, and is not strong nor elastic. It is very durable when exposed to moisture and is generally of straight grain, splitting

readily into shingles, shakes, and boards. It ranks next to the red and yellow fir commercially, and to the pioneer settlers in the valley it is the most valuable timber.

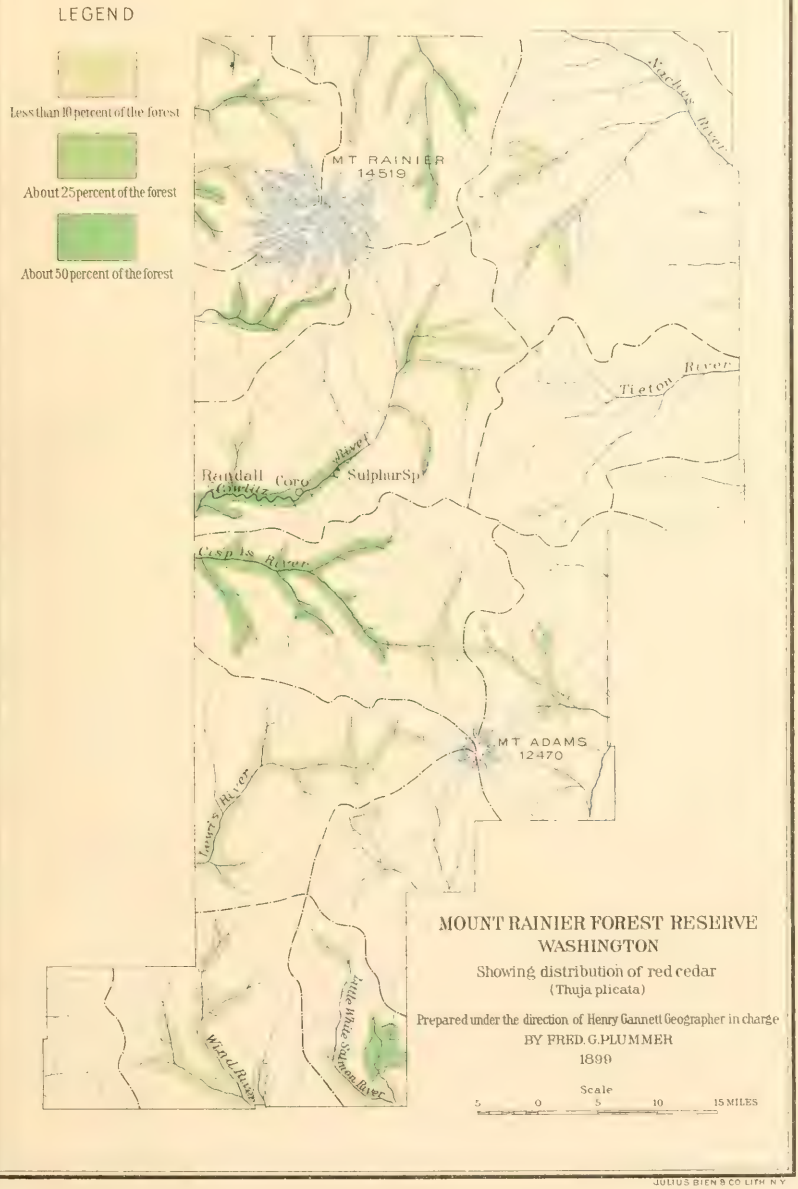
At least 95 per cent of the larger cedars are hollow butted. They always have a swell butt. Of three hollow-butted cedars of 9 feet in diameter the rate of growth, as shown by the shell of sound wood, averaged about ten years per inch radius. In several exceptional cases noted the rate of growth has been very rapid, as much as one-half inch per year for twenty years of successive growth. A fallen cedar tree 36 inches in diameter was observed to be perfectly sound, although another cedar tree 40 inches in diameter had grown over and straddled it. In swamps and swales it sometimes grows to the exclusion of other conifers, but it does not strictly form a forest of pure growth, being accompanied by alders and maples.

Chamæcyparis nootkatensis (Lamb.) Spach (Alaska cedar).

This tree is found between elevations of 2,600 and 7,400 feet. The extreme diameter is 3 feet and the height is 100 feet, of which three-fifths is crown. The wood from heart to the bark is yellow. It is light, not very hard nor strong, but is more elastic than the red cedar and very durable, but does not split as easily. Generally the branches look scrubby and give the tree a poor appearance. The outer bark is in long, thin scales and the inner bark strips easily. It never forms a forest of pure growth, but is generally associated with the mountain fir, pine, and hemlock. Generally the areas on which this cedar grows have well-defined limits, but the tree seems to require certain conditions of soil and climate, preferring shady valleys and basins. This timber would be very valuable if more widely distributed and more accessible. For turnings and fine woodwork it would excel, as its grain is even and straight, and its color uniform. It would be better material for lead pencils than many varieties of wood now used.

Larix occidentalis Nutt. (Tamarack).

This tree is found between altitudes of 2,200 and 5,600 feet. Extreme diameter is 4½ feet and height 150 feet, of which one-half is crown. The heartwood has an orange tinge and the sapwood is white. It is heavy and hard, not very strong, but is durable and does not split easily. It sometimes forms a forest of pure growth on the sides of the river canyons, and such a forest was found upon the flat divide between the Naches and American rivers. The wood makes good tie timber, and is largely used for fuel in eastern Washington. Probably this is the only timber tree of Washington which is not represented on both sides of the Cascade Mountains. It is strictly an eastern-slope tree, and is the only representative of the deciduous conifers in the reserve.



MOUNT RAINIER FOREST RESERVE
WASHINGTON

Showing distribution of red cedar
(Thuja plicata)

Prepared under the direction of Henry Gannett Geographer in charge
BY FRED. G. PLUMMER
1899

Scale
5 0 5 10 15 MILES

JULIUS BIEN & CO. LITH. N.Y.

Taxus brevifolia Nutt. (Yew).

This species of yew is found from sea level to an altitude of 4,200 feet. Generally the diameter of the mature tree is about 12 inches, but a few individuals were found with a diameter of 2 feet and a height of 40 feet, of which three-fifths is crown. The heartwood is a deep red and the sapwood has a narrow zone of cream-colored wood. It is very heavy, hard, and strong. It is exceptionally tough and durable when not exposed to extremes of moisture and dryness, and will not split after being seasoned. Although absolutely sound on the outside, one tree 14 inches in diameter was found to be badly split on concentric lines from the butt to a height of 25 feet.

Fraxinus oregona Nutt. (Ash).

This tree has a range from sea level outside of the reserve to an elevation of 2,500 feet within the reserve. Its diameter is 3 feet and height 80 feet, of which two-thirds is crown. The wood is white, heavy, hard, but not very strong as compared with the eastern ash. It is springy and quite durable when seasoned. It splits easily and is used for firewood by the settlers. The only large quantity was found in the "Big Bottom" of Cowlitz Valley, where it is associated with maples and alders.

Acer macrophyllum Pursh. (Maple).

This maple is found from sea level to an elevation of 3,300 feet. The extreme diameter is 5 feet with a height of 30 feet, three-fourths to seven-eighths of which is crown. The heartwood is straw color and the sapwood is white. It is not heavy, but is quite hard, although the tree is locally known as the soft maple. The wood is strong. It forms small groves of pure growth in the Cowlitz Bottom, but is generally associated with the ash, yew, and alder.

Populus trichocarpa Torr. and Gr. (Cottonwood).

This tree grows from sea level to an elevation of 4,200 feet. The greatest diameter is 5 feet and the height 175 feet, of which two-thirds is crown. The heartwood is of a buff color and the sapwood is white. It is light, and is not hard or strong; in fact, it has no quality to recommend it commercially as a timber wood, but has been extensively used in the manufacture of paper pulp.

Populus tremuloides Michx. (Quaking aspen).

This tree is found in the wet swales and bottoms, and has an altitudinal range from 2,500 to 5,800 feet. It does not exceed 20 inches in diameter, with a height of 60 feet, of which one-half is crown. The

wood is white and soft and of little or no value commercially. All of the large trees examined were rotten at the butt, although they looked clean and healthy outside.

QUERCUS GARRYANA Dougl. (Oak).

This oak is the only one of its species found in the reserve, and, unless the ash and yew be included, it is the only hardwood tree represented. Generally the trees are small, with short trunks, and offer nothing to the lumbermen, but a few individuals were noted with diameters of 2 feet and a height of 50 feet. They are seen at their best on the eastern slope in the watershed of the Klickitat River near Hell Roaring Canyon. This oak is considered first-class fuel, and has been cut extensively along the Columbia River (outside the reserve) for this purpose.

RANGE OF TREE SPECIES.

The accompanying diagram (Pl. XLI) shows in a graphic way the altitudinal range of the species of timber trees found in the reserve. The datum is given as sea level, and those species which extend outside the reserve to tide water are so shown upon the diagram.

The lines showing each species have been widened into forms which are intended to show by their width the relative development of the species. This diagram was compiled from observations taken at 521 locations, ranging in altitude from 700 to 8,200 feet.

The name of each species is placed in the zone to which the tree belongs.

RATE OF GROWTH OF TIMBER TREES.

The average rate of growth of all the conifers, as determined by measuring over 8,000 annual rings, is 0.0741 of an inch per year.

In the table which follows the number of annual rings is given for each 3 inches of radius, and therefore show an increase or decrease in the rate of growth. For example, *Pinus murrayana*, according to the table, shows an increase in the number of rings for each 3 inches of radius. Therefore the rings are closer together near the bark than at the heart, and the rate of growth decreases with age.

When the diameter of a tree was over 36 inches, the measurements are continued in regular order on the lines below, as in the case of *Pseudotsuga taxifolia*.

Table showing rate of growth of timber trees.

Name of tree.	Diameter of wood.	Thickness of bark.	Total diameter.	Number of rings counted on radius from the center.						Age of tree.
				1.9 inches.	4.6 inches.	7.9 inches.	10 inches.	13 inches.	16 inches.	
	In.	*In.*	*In.*							*Years*
Pinus monticola	7	$\frac{1}{4}$	$7\frac{1}{2}$	36	11	....	....	....	....	47
Do	22	$\frac{3}{4}$	$23\frac{1}{2}$	15	13	17	12	....	....	57
Do	16	$\frac{1}{2}$	17	19	19	17	....	....	....	55
Pinus ponderosa	25	2	29	29	36	43	39	7	....	154
Do	$31\frac{1}{2}$	$2\frac{1}{2}$	$36\frac{1}{2}$	27	33	28	38	52	15	193
Do	22	2	26	41	41	61	59	....	....	202
Pinus murrayana	19	$\frac{1}{2}$	$19\frac{1}{2}$	34	38	82	39	....	....	193
Do	14	$\frac{1}{2}$	$14\frac{1}{2}$	45	50	62	....	....	....	157
Do	19	$\frac{1}{2}$	$19\frac{1}{2}$	26	31	45	5	....	....	107
Do	18	$\frac{1}{2}$	$18\frac{1}{2}$	18	28	54	....	....	....	100
Pinus albicaulis	9	$\frac{1}{2}$	$9\frac{1}{2}$	130	55	....	....	....	....	185
Do	13	$\frac{1}{2}$	14	133	99	35	....	....	....	267
Do	14	$\frac{1}{2}$	15	85	115	45	....	....	....	245
Do	$20\frac{1}{2}$	$\frac{1}{2}$	21	42	44	59	46	....	....	191
Do	$9\frac{1}{2}$	$\frac{1}{2}$	10	48	33	....	....	....	....	81
Abies nobilis	22	$\frac{3}{4}$	$22\frac{3}{4}$	27	15	14	9	....	....	65
Do	17	$\frac{1}{2}$	$17\frac{1}{2}$	37	18	12	....	....	....	67
Do	31	1	33	56	36	28	24	24	6	174
Abies amabilis	20	$\frac{1}{2}$	$20\frac{1}{2}$	16	20	13	6	....	....	55
Do	12	$\frac{1}{2}$	13	71	25	....	....	....	....	96
Do	11	$\frac{1}{2}$	$11\frac{1}{2}$	68	73	....	....	....	....	141
Do	20	$\frac{3}{4}$	$20\frac{3}{4}$	132	88	55	13	....	....	288
Do	10	$\frac{1}{4}$	$10\frac{1}{4}$	40	28	....	....	....	....	68
Do	$15\frac{1}{2}$	$\frac{1}{4}$	16	71	51	50	....	....	....	172
Abies concolor	20	1	22	40	60	96	38	....	....	234
Do	12	$\frac{1}{2}$	$13\frac{1}{2}$	74	105	....	....	....	....	179
Do	20	$\frac{3}{4}$	$21\frac{1}{2}$	52	37	53	27	....	....	169
Do	17	1	19	64	67	83	....	....	....	214
Do	11	$\frac{1}{2}$	$11\frac{1}{2}$	119	98	....	....	....	....	217
Abies lasiocarpa	14	$\frac{3}{4}$	$15\frac{1}{2}$	60	50	10	....	....	....	120
Do	15	$\frac{3}{4}$	$16\frac{1}{2}$	60	48	17	....	....	....	125
Do	10	$\frac{1}{2}$	11	40	41	....	....	....	....	81
Do	19	$\frac{1}{2}$	20	38	43	70	....	....	....	151
Do	10	$\frac{1}{4}$	$10\frac{1}{2}$	34	14	....	....	....	....	48
Tsuga mertensiana	31	1	33	64	70	65	63	84	12	358
Do	29	$\frac{3}{4}$	$30\frac{1}{2}$	30	24	25	36	41	....	156

Table showing rate of growth of timber trees—Continued.

Name of tree.	Radius of wood.	Thickness of bark.	Diameter.	Number of rings counted on radius from the center.						Age of tree.
				inches.	inches.	inches.	inches.	inches.	inches.	
	In.	*In.*	*In.*							*Years.*
Tsuga pattoniana	14½	1½	17½	54	62	60				176
Do	13	1	15	58	58	32				148
Picea engelmanni	13½	¼	14	65	23	4				92
Do	29	¾	30½	30	16	16	20	24		106
Do	20	1	22	30	40	43	28			141
Pseudotsuga taxifolia	42	0	84	39	40	40	41	41	41	
Do				40	40	41	41	40	40	484
Do	120	18	156	9	11	16	14	15	25	
Do				31	19	18	21	18	15	
Do				18	15	20	21	25	28	
Do				32	37					408
Do	30	¾	31½	38	32	12	9	17		108
Do	30	¾	31½	73	14	10	11	10		118
Do	40	4	48	15	15	22	35	46	68	
Do				41						242
Do	38	3	44	11	18	30	38	46	56	
Do				19						216
Do	38	2½	43	17	47	34	50	64	110	
Do				40						362
Do	31	2	35	58	54	62	88	98	28	388
Thuja plicata	52	1	54	48	18	16	14	13	17	
Do				20	22	14				182
Do	34	¼	34½	26	27	10	10	14	10	97
Do	40	½	40½	27	21	21	6	8	15	
Do				15						113
Do	18	1	20	25	35	42	46	56	50	254
Chamæcyparis nootkatensis	19½	½	20	78	74	97	23			272
Do	19	¼	19½	48	60	112	10			230
Do	28½	½	29½	(*a*)						380?
Do	22	½	23	60	74	90	59			283
Larix occidentalis	19	2	23	15	14	32	9			70
Fraxinus oregona	24	½	25½	25	25	42	50			142
Do	26½	¾	28	25	25	29	44	25		148
Do	5	½	5½	34						34
Do	10½	⅝	11½	38	23					61

a Rings too close to count accurately.

Table showing rate of growth of timber trees—Continued.

Name of tree.	Diameter of wood.	Thickness of bark.	Total diameter.	Number of rings counted on radius from the center.						Age of tree.
				1 to 3 inches.	3 to 5 inches.	5 to 7 inches.	7 to 9 inches.	9 to 11 inches.	11 to 13 inches.	
	In.	*In.*	*In.*							*Years*
Acer macrophyllum	11	½	12	68	35					103
Do	28	1	30	48	23	26	38	23		158
Do	6	¼	6½	62						62
Populus trichocarpa	8	½	9	33	10					43
Do	23	1¼	25½	20	21	17	26			84
Populus tremuloides	14	½	15	24	21	8				53
Do	18	¾	19½	30	26	30				86
Taxus brevifolia	4	⅛	4⅛	53						53
Do	5	⅛	5⅛	68						68
Do	16	⅛	16⅛	63	53	63				179
Do	10	⅛	10⅛	77	81					158
Alnus oregona	9½	¼	10	36	23					59
Pyrus rivularis	4	⅛	4⅛	48						48
Rhamnus purshiana	6	⅛	6⅛	60						60
Do	5½	⅛	5⅝	44						44
Acer circinatum	4	⅛	4⅛	50						50
Do	7	⅛	7⅛	41	7					48
Salix lasiandra	4	¼	4½	18						18
Cornus nuttallii	4	⅛	4⅛	32						32

DEFECTS AND DISEASES OF TIMBER TREES.

About 5 per cent of the forest stand within the reserve is composed of dead snags scattered through the green and live growth. This condition is common to all forests, as it results from the fact that trees die. The cause, however, is not only that of final maturity, for the great majority of these standing snags were young or middle-aged trees, many of which died from lack of light and air—killed by their more vigorous neighbors.

Individual cases were noted where camp fires had run up and killed single trees, also where lightning had struck and killed trees without the fire spreading. Not uncommonly a heavy fall of snow will break the upper branches of a tree, and these falling will strip the trunk of all foliage—a setback that only a vigorous and well-situated conifer can survive.

In those areas where the soil is excessively moist, a common defect is the hollow butt or ground rot. In such places the root hold is not good, and the conifers, lacking the taproot, compensate by developing an enormous growth of roots on a plane conforming with the surface of the ground, thus increasing the base area upon which they stand. Such trees have the "swell butts," and it is not unusual to see a tree of which a section made at the surface of the ground would have from five to ten times the area of a parallel section made 15 feet above it. In these swell butts there is no straight-grain lumber and the wood is coarse, resulting from the rapid growth, which in the case of the red cedar (*Thuja plicata*) amounts to as much as one-half inch annually.

In logging, it is customary to cut the trees above the swell butts, leaving on the stump that portion of the trunk with the decayed center, and in the case of the firs to reject the sappy base of the tree. Cedars with decayed butts generally show dead tops, but this is of minor interest to the lumberman, who seldom cuts logs far into the crown.

In the ideal forest of the lumberman the trees have clear trunks to 100 or 125 feet of height and the crowns form a continuous cover as seen either from below or above. Seldom is the seedling in such a forest able to compete under such conditions, for the existence of such a forest means the elimination of perhaps a hundred seedlings before supremacy in the sapling stage had been established, and the final elimination of at least 90 per cent of the saplings before each successful tree grows skyward in the final competition for light. In areas where this severe competition does not obtain, the tree trunks are "limby," and even when the trunks appear clear at first glance the logs contain "pin knots," which, running through the heartwood, render the lumber second or third class. Large trees standing in the open, where the winds have greater effect, generally throw very few limbs toward the prevailing winds, but compensate on the protected side. The growth of the trunk is then eccentric to the heart and the lumber is not even grained. In the higher and more exposed areas the trees are often without limbs on the storm side, generally the southwest side, and the trees are stunted, as described elsewhere in this report.

It can not be said that the giant shelf fungus (*Polyporus* sp.) is a factor in killing or even in hastening the death of the large dead timber upon which it is found. Of the many hundreds of these fungi that were observed, not one was found upon a living tree. The arceuthobium, on the contrary, attacks the living trees, and its range of activity appears not to be limited by altitude. It is a parasite on the foliage of the pines, firs, and hemlocks of eastern Washington, and in some cases, particularly on the mountain fir (*Abies lasiocarpa*), will cover the entire tree and, turning the foliage a red color, makes the tree a conspicuous object.

A. PINES AND RED FIR.

B. RED FIR IN COWLITZ BOTTOM

ESTIMATES OF TIMBER.

WHITE RIVER WATERSHED.

Density of timber in White River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M
0 to 2,000	33,570	33,570,000
2,000 to 5,000	18,600	65,100,000
5,000 to 10,000	16,450	123,375,000
10,000 to 25,000	29,150	510,125,000
25,000 to 50,000	16,000	600,000,000
50,000 to 100,000	20,850	1,563,750,000
Total	134,620	2,895,920,000

Average stand per acre for entire watershed, 18,544 feet B. M.

Area of timbered and other lands in White River watershed, Washington.

	Acres.
Timbered area	134,620
Burned area	10,200
Glaciers	8,900
Timberless area	2,440
Total	156,160

Proportions and amounts of timber species in White River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	45	1,303,164,000
Hemlock	25	723,980,000
Red cedar	15	434,388,000
Engelmann spruce	5	144,796,000
White pine	3	86,877,600
Alaska cedar	2	57,918,400
White fir Lovely fir Noble fir Mountain fir Mountain hemlock	5	144,796,000
Total	100	2,895,920,000

PUYALLUP RIVER WATERSHED.

Density of timber in Puyallup River watershed, Washington.

Stand in feet B. M. per acre	Number of acres	Total stand.
		Feet B. M.
0 to 2,000	30,160	30,160,000
2,000 to 5,000	26,770	93,695,000
5,000 to 10,000	11,150	83,625,000
10,000 to 25,000	8,500	148,750,000
25,000 to 50,000	10,900	408,750,000
50,000 to 100,000	12,470	935,250,000
Total	99,950	1,700,230,000

Average stand per acre for entire watershed, 14,428 feet B. M.

Area of timbered and other lands in Puyallup watershed, Washington.

	Acres.
Timbered area	99,950
Burned area	2,580
Glaciers	12,600
Timberless area	2,710
Total	117,840

Proportions and amounts of timber species in Puyallup River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	50	850,115,000
Hemlock	25	425,057,500
Red cedar	10	170,023,000
Noble fir	5	85,011,500
White fir	3	51,006,900
Alaska cedar	2	34,004,600
Lodgepole pine		
Engelmann spruce		
Mountain fir	5	85,011,500
Mountain hemlock		
White pine		
Total	100	1,700,230,000

NISQUALLY RIVER WATERSHED.

Density of timber in Nisqually River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	16,610	16,610,000
2,000 to 5,000	3,360	11,760,000
5,000 to 10,000	6,770	50,775,000
10,000 to 25,000	5,960	104,300,000
25,000 to 50,000	6,370	238,875,000
50,000 to 100,000		
Total	39,070	422,320,000

Average stand per acre for entire watershed, 5,414 feet B. M.

Area of timbered and other lands in Nisqually River watershed, Washington.

	Acres.
Timbered area	39,070
Burned area	27,810
Glaciers	8,100
Timberless area	3,020
Total	78,000

Proportions and amounts of timber species in Nisqually River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	50	211,160,000
Hemlock	25	105,580,000
Red cedar	10	42,232,000
White fir	5	21,116,000
Noble fir	4	16,892,800
Alaska cedar	1	4,223,200
Lovely fir		
Engelmann spruce		
Mountain fir	5	21,116,000
Mountain hemlock		
White pine		
Total	100	422,320,000

COWLITZ RIVER WATERSHED.

Density of timber in Cowlitz River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	37,850	37,850,000
2,000 to 5,000	96,380	337,330,000
5,000 to 10,000	12,540	94,050,000
10,000 to 25,000	47,610	833,175,000
25,000 to 50,000	3,720	139,500,000
50,000 to 100,000	2,560	192,000,000
Total	200,660	1,633,905,000

Average stand per acre for entire watershed, 5,611 feet B. M.

Area of timbered and other lands in Cowlitz River watershed, Washington.

	Acres.
Timbered area	200,660
Burned area	86,900
Glaciers	2,900
Timberless area	740
Total	291,200

Proportions and amounts of timber species in Cowlitz River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	55	898,647,750
Hemlock	25	408,476,250
Red cedar	5	81,695,250
White fir	5	81,695,250
Noble fir	4	65,356,200
Alaska cedar	1	16,339,050
Lowland fir		
Mountain fir		
Mountain hemlock	5	81,695,250
White pine		
Engelmann spruce		
Total	100	1,633,905,000

CISPUS RIVER WATERSHED.

Density of timber in Cispus River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	27,400	27,400,000
2,000 to 5,000	64,200	224,700,000
5,000 to 10,000	24,300	182,250,000
10,000 to 25,000	76,800	1,344,000,000
25,000 to 50,000		
50,000 to 100,000		
Total	192,700	1,778,350,000

Average stand per acre for entire watershed, 7,535 feet B. M.

Area of timbered and other lands in Cispus River watershed, Washington.

	Acres.
Timbered area	192,700
Burned area	43,000
Glaciers	100
Timberless area	200
Total	236,000

Proportions and amounts of timber species in Cispus River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	45	800,257,500
Hemlock	30	533,505,000
Red cedar	10	177,835,000
Noble fir	5	88,917,500
White fir	5	88,917,500
Lovely fir		
Mountain fir		
Mountain hemlock	5	88,917,500
White pine		
Alaska cedar		
Total	100	1,778,350,000

LEWIS RIVER WATERSHED.

Density of timber in Lewis River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	14,730	14,730,000
2,000 to 5,000	48,450	169,575,000
5,000 to 10,000	61,810	463,575,000
10,000 to 25,000	7,900	138,250,000
25,000 to 50,000	54,730	2,052,375,000
50,000 to 100,000	1,620	121,500,000
Total	189,240	2,960,005,000

Average stand per acre for entire watershed, 13,295 feet B. M.

Area of timbered and other lands in Lewis River watershed, Washington.

	Acres.
Timbered area	189,240
Burned area	32,360
Glaciers	350
Timberless area	690
Total	222,640

Proportions and amounts of timber species in Lewis River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	50	1,480,002,500
Hemlock	20	592,001,000
Noble fir	15	444,000,750
Red cedar	5	148,000,250
Lovely fir	5	148,000,250
White fir Mountain fir Mountain hemlock White pine	5	148,000,250
Total	100	2,960,005,000

WASHOUGAL RIVER WATERSHED.

Density of timber in Washougal River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000		
2,000 to 5,000		
5,000 to 10,000	2,370	17,775,000
10,000 to 25,000		
25,000 to 50,000		
50,000 to 100,000	910	68,250,000
Total	3,280	86,025,000

Average stand per acre for entire watershed, 26,227 feet B. M.
Area of watershed, all timbered, 3,280 acres.

Proportions and amounts of timber species in Washougal River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	30	25,807,500
Noble fir	25	21,506,250
Lovely fir	25	21,506,250
Hemlock	15	12,903,750
Red cedar White fir White pine	5	4,301,250
Total	100	86,025,000

ROCK CREEK WATERSHED.

Density of timber in Rock Creek watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000		
2,000 to 5,000		
5,000 to 10,000	690	5,175,000
10,000 to 25,000		
25,000 to 50,000	690	25,875,000
50,000 to 100,000	4,660	349,500,000
Total	6,040	380,550,000

Average stand per acre for entire watershed, 63,005 feet B. M.
Area of watershed, all timbered, 6,040 acres.

Proportions and amounts of timber species in Rock Creek watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	30	114,165,000
Noble fir	25	95,137,500
Lovely fir	25	95,137,500
Hemlock	15	57,082,500
Red cedar White fir White pine	5	19,027,500
Total	100	380,550,000

WIND RIVER WATERSHED.

Density of timber in Wind River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	21,810	21,810,000
2,000 to 5,000	7,970	27,895,000
5,000 to 10,000	3,220	24,150,000
10,000 to 25,000	17,700	309,750,000
25,000 to 50,000	52,900	1,983,750,000
50,000 to 100,000	18,430	1,382,250,000
Total	122,030	3,749,605,000

Average stand per acre for entire watershed, 25,858 feet B. M.

Area of timber and other lands in the Wind River watershed, Washington.

	Acres.
Timbered area	122,030
Burned area	22,970
Total	145,000

Proportions and amounts of timber species in Wind River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	45	1,687,322,250
Hemlock	15	562,440,750
Noble fir	10	374,960,500
Lovely fir	10	374,960,500
White fir	5	187,480,250
Red cedar	5	187,480,250
White pine	5	187,480,250
Lodgepole pine Mountain fir Mountain hemlock Engelmann spruce	5	187,480,250
Total	100	3,749,605,000

LITTLE WHITE SALMON RIVER WATERSHED.

Density of timber in Little White Salmon River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	16,080	16,080,000
2,000 to 5,000	39,590	138,565,000
5,000 to 10,000	4,720	35,400,000
10,000 to 25,000	6,430	112,525,000
25,000 to 50,000	.....	.....
50,000 to 100,000	.....	.....
Total	66,820	302,570,000

Average stand per acre for entire watershed, 4,223 feet B. M.

Area of timbered and other lands in Little White Salmon River watershed, Washington.

	Acres.
Timbered area	66,820
Burned area	4,830
Total	71,650

Proportions and amounts of timber species in Little White Salmon River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Red or yellow fir	55	166,413,500
Hemlock	10	30,257,000
Red cedar	10	30,257,000
White pine	5	15,128,500
Yellow pine	5	15,128,500
Engelmann spruce	5	15,128,500
White fir	3	9,077,100
Noble fir	2	6,051,400
Tamarack Lovely fir Mountain fir Mountain hemlock	5	15,128,500
Total	100	302,570,000

WHITE SALMON RIVER WATERSHED.

Density of timber in White Salmon River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	13,370	13,370,000
2,000 to 5,000	23,670	82,845,000
5,000 to 10,000	30,650	229,875,000
10,000 to 25,000	5,990	104,825,000
25,000 to 50,000	2,890	108,375,000
50,000 to 100,000		
Total	76,570	539,290,000

Average stand per acre for entire watershed, 5,106 feet B. M.

Area of timbered and other lands in White Salmon River watershed, Washington.

	Acres.
Timbered area	76,570
Burned area	27,200
Glaciers	450
Timberless area	1,380
Total	105,600

Proportions and amounts of timber species in White Salmon River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Yellow pine	40	215,716,000
Red or yellow fir	30	161,787,000
Tamarack	10	53,929,000
White pine	5	26,964,500
Hemlock	4	21,571,600
Noble fir	3	16,178,700
Red cedar	3	16,178,700
White fir		
Lovely fir		
Lodgepole pine		
Engelmann spruce	5	26,964,500
Mountain fir		
Mountain hemlock		
Total	100	539,290,000

KLICKITAT RIVER WATERSHED.

Density of timber in Klickitat River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	29,580	29,580,000
2,000 to 5,000	31,660	110,810,000
5,000 to 10,000	15,070	113,025,000
10,000 to 25,000	35,440	620,200,000
25,000 to 50,000	17,600	660,000,000
50,000 to 100,000	4,460	334,500,000
Total	133,810	1,868,115,000

Average stand per acre for entire watershed, 11,075 feet B. M.

Area of timbered and other lands in Klickitat River watershed, Washington.

	Acres.
Timbered area	133,810
Burned area	30,230
Glaciers	1,400
Timberless area	3,240
Total	168,680

Proportions and amounts of timber species in Klickitat River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Yellow pine	55	1,027,463,250
Red or yellow fir	20	373,623,000
Tamarack	10	186,811,500
White pine	5	93,405,750
Mountain hemlock	5	93,405,750
White fir		
Hemlock		
Engelmann spruce		
Mountain fir		
Lovely fir	5	93,405,750
Red cedar		
Alaska cedar		
Lodgepole pine		
Total	100	1,868,115,000

ATANUM RIVER WATERSHED.

Density of timber in Atanum River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	12,790	12,790,000
2,000 to 5,000	13,240	46,340,000
5,000 to 10,000		
10,000 to 25,000		
25,000 to 50,000		
50,000 to 100,000		
Total	26,030	59,130,000

Average stand per acre for entire watershed, 1,454 feet B. M.

Area of timbered and other lands in Atanum River watershed, Washington.

	Acres.
Timbered area	26,030
Burned area	14,630
Total	40,660

Proportions and amounts of timber species in Ataman River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Yellow pine	60	35,478,000
Red or yellow fir	15	8,869,500
Tamarack	10	5,913,000
Mountain fir	5	2,956,500
Mountain hemlock	3	1,773,900
Lodgepole pine	2	1,182,600
White fir	5	2,956,500
Lovely fir		
Engelmann spruce		
White pine		
Red cedar		
Alaska cedar		
Total	100	59,130,000

TIETON RIVER WATERSHED.

Density of timber in Tieton River watershed, Washington.

Stand in feet B.M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	45,270	45,270,000
2,000 to 5,000	71,520	250,320,000
5,000 to 10,000	29,970	224,775,000
10,000 to 25,000	4,610	80,675,000
25,000 to 50,000	940	35,250,000
50,000 to 100,000		
Total	152,310	636,290,000

Average stand per acre for entire watershed, 3,765 feet B. M.

Area of timbered and other land in Tieton River watershed, Washington.

	Acres.
Timbered area	152,310
Burned area	16,370
Timberless area	320
Total	169,000

Proportions and amounts of timber species in Tieton River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Yellow pine	50	318,145,000
Red or yellow fir	35	222,701,500
Tamarack	10	63,629,000
Red cedar		
Engelmann spruce		
White fir		
White pine	5	31,814,500
Lodgepole pine		
Mountain fir		
Mountain hemlock		
Alaska cedar		
Total	100	636,290,000

NACHES RIVER WATERSHED.

Density of timber in Naches River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	108,500	108,500,000
2,000 to 5,000	188,300	659,050,000
5,000 to 10,000	16,000	120,000,000
10,000 to 25,000	5,410	94,675,000
25,000 to 50,000		
50,000 to 100,000		
Total	318,210	982,225,000

Average stand per acre for entire watershed, 3,002 feet B. M.

Area of timbered and other lands in Naches River watershed, Washington.

	Acres.
Timbered area	318,210
Burned area	7,510
Timberless area	1,450
Total	327,170

Proportions and amounts of timber species in Naches River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Feet B. M.*
Yellow pine	45	442,001,250
Red or yellow fir	25	245,556,250
Tamarack	20	196,445,000
Hemlock	5	49,111,250
Red cedar		
White pine		
Lodgepole pine		
Noble fir		
Lovely fir	5	49,111,250
White fir		
Mountain fir		
Mountain hemlock		
Engelmann spruce		
Alaska cedar		
Total	100	982,225,000

YAKIMA RIVER WATERSHED.

Density of timber in Yakima River watershed, Washington.

Stand in feet B. M. per acre.	Number of acres.	Total stand.
		Feet B. M.
0 to 2,000	3,250	3,250,000
2,000 to 5,000	4,430	15,505,000
5,000 to 10,000		
10,000 to 25,000		
25,000 to 50,000		
50,000 to 100,000		
Total	7,680	18,755,000

Average stand per acre for entire watershed, 2,442 feet B. M.
Area of watershed, all timbered, 7,680 acres.

Proportions and amounts of timber species in Yakima River watershed, Washington.

Species.	Proportion.	Amount.
	Per cent.	*Fet B. M.*
Yellow pine	45	8,439,750
Red or yellow fir	30	5,626,500
Tamarack	10	1,875,500
Engelmann spruce	10	1,875,500
Mountain hemlock		
[illegible]		
White fir	5	937,750
White pine		
Lodgepole pine		
Red cedar		
Total	100	18,755,000

SUMMARY OF ESTIMATES.

Total timber estimates, arranged by watersheds.

Watershed.	Area.	Average per acre.	Total.
	Acres.	*Fet B. M.*	*Fet B. M.*
White River	156,160	18,544	2,895,920,000
Puyallup River	117,840	14,428	1,700,230,000
Nisqually River	78,000	5,414	422,320,000
Cowlitz River	291,200	5,611	1,633,905,000
Cispus River	236,000	7,535	1,778,350,000
Lewis River	222,640	13,295	2,960,005,000
Washougal River	3,280	26,227	86,025,000
Rock Creek	6,040	63,005	380,550,000
Wind River	145,000	25,858	3,749,605,000
Little White Salmon River	71,650	4,223	302,570,000
White Salmon River	105,600	5,106	539,290,000
Klickitat River	168,680	11,075	1,868,115,000
Atanum River	40,660	1,454	59,130,000
Tieton River	169,000	3,765	636,290,000
Naches River	327,170	3,002	982,225,000
Yakima River	7,680	2,442	18,755,000
Total	2,146,600	9,323	20,013,285,000

Total timber estimates, arranged by species of trees.

	Feet B. M.		Feet B. M.
Red or yellow fir	8,555,218,750	Tamarack	512,385,000
Hemlock	3,533,642,000	Mountain hemlock	280,677,000
Yellow pine	2,062,371,750	Engelmann spruce	271,785,000
Red cedar	1,317,078,500	Mountain fir	200,130,000
Noble fir	1,247,883,500	Alaska cedar	151,326,000
Lovely fir	749,267,500	Lodgepole pine	73,267,000
White fir	538,735,000		
White pine	519,518,000	Total	20,013,285,000

COMMERCIAL USES OF TIMBERS.

In importance, all things considered, the principal timber trees of the reserve will at this time rank commercially in the following order:

Commercial rank of timber trees in Mount Rainier Reserve, Washington.

Red or yellow fir (Pseudotsuga taxifolia).
Red cedar (Thuja plicata).
Tide-land spruce (Picea sitchensis).
Yellow pine (Pinus ponderosa).
White pine (Pinus monticola).
Noble fir (Abies nobilis).
Lovely fir (Abies amabalis).
White fir (Abies concolor).
Hemlock (Tsuga mertensiana).
Tamarack (Larix occidentalis).

The above order results from size, quantity, and accessibility of the trees and the properties of the various woods.

If arranged in the order of the desirable properties of the woods and ignoring the question of size, quantity, and accessibility, the timbers will take rank as follows:

Rank of timber trees in order of desirable properties.

1. Alaska cedar
2. Noble fir
3. Tideland spruce
4. White pine
5. Red cedar
6. Red or yellow fir
7. Lovely fir
8. Hemlock
9. Yellow pine
10. White fir
11. Tamarack.

The uses to which the various woods are generally put are as follows:

Uses of woods of trees in Mount Rainier Reserve, Washington.

Bridge timbers	Red and yellow fir.
Lumber	Red and yellow fir, red cedar, tideland spruce, yellow pine, white pine, noble fir, lovely fir.
Shingles	Red cedar, white fir.
Piles	Red fir.
Telegraph poles	Red cedar.
Railroad ties	Tamarack, red and yellow fir, white pine, red cedar.
Fence posts and fuel	All kinds.
Paper pulp	The following trees in the order of their importance: Tideland spruce, cottonwood, quaking aspen, white fir, red and yellow fir, hemlock, maple.
Furniture and cabinetwork	In addition to the lumber woods enumerated some oak, ash, and maple have been used.

MARKETS AND PRICES.

In the absence of railroads and other well-established lines of travel the various divisions of the reserve are, by watersheds, commercially tributary to the outlying markets, namely, Tacoma, Chehalis, Portland, and North Yakima. The following tables show these watersheds and the markets which they at present would naturally supply.

Markets for watersheds in Mount Rainier Reserve, Washington.

Watersheds.	Area.	Tributary to—
	Acres.	
White River	156,160	Tacoma.
Puyallup River	117,840	Do.
Nisqually River	78,000	Do.
Cowlitz River	291,200	Tacoma or Chehalis.
Cispus River	236,000	Do.
Lewis River	222,640	Portland.
Washougal River	3,280	Do.
Rock River	6,040	Do.
Wind River	145,000	Do.
Little White Salmon River	71,650	Do.
White Salmon River	105,600	Do.
Klickitat River	168,680	Do.
Atanum River	40,660	North Yakima.
Tieton River	169,000	Do.
Naches River	327,170	Do.
Yakima [illegible]	[illegible]81	Do.

Prices of fir lumber in markets adjacent to Mount Rainier Reserve, Washington.

Grade.	Size.	Finish.	Per M feet B. M. at—	
			Tacoma or Portland.	North Yakima.
	Inches			
Common	1 by 12	Rough	$7.50	$13.50
Do	do	Surface 2 sides	10.50	16.50
Flooring V. G.:				
Number 1	1 by 4	Dressed and matched	19.00	24.50
Number 2	do	do	14.00	19.50
Ceiling:				
Number 1	$\frac{5}{8}$ by 6	Beaded and plain	15.50	19.00
Number 2	do	do	13.50	17.00
Wainscoting:				
Number 1	$\frac{5}{8}$ by 4		12.00	17.00
Number 2	do		10.00	15.00
Shiplap, common	1 by 8		8.50	14.50
Fencing:				
Number 1	1 by 4		7.50	14.50
Number 2	do		6.50	13.50
Pickets	1 by 3 or 1¼ by 1¼.		10.50	14.50
Lath	¾ by 1½ by 4 per 1,000.		1.65	2.75

Prices of cedar run from 25 to 40 per cent more than above.
Prices of spruce run from 10 to 50 per cent more than above.
Prices of hemlock run same as fir (no demand).
Shingles cost from $1 to $3 per thousand, according to quality.

Price of large or long dressed fir timbers at Tacoma.

Size.	Length.	Price per M feet B. M.
	Feet	
8 by 8 inches	50	$12.50
8 by 8 inches	100	35.00
12 by 12 inches	50	12.50
12 by 12 inches	100	35.00
14 by 14 inches	50	13.25
14 by 14 inches	100	37.50
16 by 16 inches	50	14.00
16 by 16 inches	100	40.00
18 by 18 inches	50	15.50
18 by 18 inches	100	44.00
20 by 20 inches	50	17.00
20 by 20 inches	100	48.00
22 by 22 inches	50	20.00
22 by 22 inches	100	53.00
24 by 24 inches	50	23.00
24 by 24 inches	100	59.00

Prices of larger timbers are special.

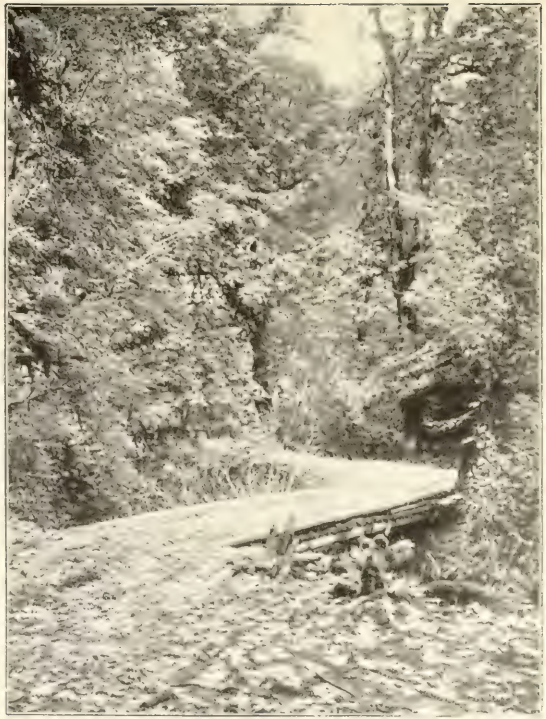
UNDERBRUSH.

Small areas on the eastern slope are of open pine forests, carpeted with pine grass (*Calamagrostis suksdorfi*) and without litter or underbrush, but the general statement is true that on both slopes of the mountains the underbrush is heavy as compared with eastern forest areas, and on the western slope it is not uncommon for the growth to be so rank as to be impenetrable.

The term underbrush as here used does not include young trees of the same species as those composing the forest, nor does it include grasses, sedges, weeds, or ferns. In the typical forest of conifers there is considerable growth of the deciduous shrubs, which are properly included as underbrush and are so called locally. The species common to both slopes are as follows:

Underbrush in Mount Rainier Reserve, Washington.

SPECIES FOUND THROUGHOUT THE RESERVE.	
Oregon grape	Berberis nervosa Pursh.
Washington holly	Berberis aquifolium Pursh.
	Pachystima myrsinites Raf.
Bearberry	Rhamnus purshiana DC.
Soapwood	Ceanothus velutinus Dougl., common.
	Ceanothus sanguineus Pursh.



A. MAPLE GROVE.

B. YELLOW FIR 12½ FEET IN DIAMETER.

Vine maple	Acer circinatum Pursh.
Smooth maple	Acer glabrum Torr.
Wild cherry	Prunus emarginata var. mollis Brewer.
	Prunus demissa Walp.
Wild rose	Rosa gymnocarpa Nutt.
	Rosa nutkana Presl.
	Rosa californica Cham. and Schlecht.
Hardhack	Spiræa douglasii Hook.
Arrowwood	Spiræa discolor Pursh.
Alpine spiræa	Spiræa rosea Gray.
	Spiræa corymbosa Raf.
Mountain ash	Pyrus sambucifolia (Cham. and Schlecht) Roem.
Crab apple	Pyrus rivularis Dougl.
Juneberry	Amelanchier alnifolia Nutt.
Thimbleberry	Rubus nutkanus Moc.
Salmon berry	Rubus spectabilis Pursh.
Raspberry	Rubus leucodermis Dougl.
Blackberry	Rubus ursinus Cham. and Schlecht.
Snowy or birds'-foot bramble	Rubus pedatus Smith.
Downy bramble	Rubus lasiococcus Gray.
Grease wood	Purshia tridentata DC.
Nine-bark	Neillia opulifolia B. and H.
Mock orange or wild syringa	Philadelphus lewisii Pursh.
Red-flowering currant	Ribes sanguineum Pursh.
Western fetid currant	Ribes bracteosum Dougl.
	Ribes viscosissimum Pursh.
	Ribes cereum Dougl.
	Ribes ciliosum Howell.
Prickly gooseberry	Ribes lacustre var. molle Gray.
Black-berried gooseberry	Ribes divericatum Dougl.
Devil's walking club	Fatsia horrida B. and H.
Canada dogwood	Cornus canadensis Linn.
Western dogwood	Cornus nuttallii Aud.
White-berried dogwood	Cornus pubescens Nutt.
White elder	Sambucus melanocarpa Gray.
Red-berried elder	Sambucus racemosa Linn.
	Sambucus glauca Nutt. ?
Viburnum	Viburnum pauciflorum Pylaie.
Snowberry	Symphoricarpus racemosus Michx.
Western honeysuckle	Lonicera ciliosa Poir.
Bush honeysuckle	Lonicera involucrata Banks.
Red huckleberry	Vaccinium parvifolium Smith.
Myrtle-leaved huckleberry	Vaccinium myrtilloides Hook.
Small red huckleberry	Vaccinium myrtillus var. microcephyllum Hook.
Cranberry	(species not determined.)
Manzanita	Arctostaphylos tomentosa Dougl.
Kinnikinick	Arctostaphylos uvaursi Spr.
Mountain salal	Gaultheria ovatifolia Gray.
Pale laurel	Kalmia glauca Ait. var.
	Menziesia ferruginea Smith.
White rhododendron	Rhododendron albiflorum Hook.

Labrador tea	Ledum latifolium Ait.
Dwarf birch	Betula glandulosa Michx.
Mountain alder	Alnus sinuata Ryd.
	Alnus rhombifolia Nutt.
Hazle	Corylus rostrata Ait., very common.
Bee willow	Salix sitchensis Sanson.
Marsh willow	Salix lasiandra Benth.
Quaking aspen	Populus tremuloides Michx.
Alpine juniper	Juniperus communis Linn.

SPECIES FOUND ONLY ON THE WESTERN SLOPE.

Madroña	Arbutus menziesii Pursh.
Salal	Gaultheria shallon Pursh.
State flower	Rhododendron californicum Hook.
Honeysuckle	Lonicera hispidula Dougl.
Black huckleberry	Vaccinium ovatum Pursh.

SPECIES FOUND ONLY ON THE EASTERN SLOPE.

Scrub oak	Quercus garryana Dougl.
Dogwood	Cornus stolonifera Michx.
Oregon grape	Berberis repens Lindl.
Sagebrush	Artemisia tridentata Nutt.
Missouri currant	Ribes aureum Pursh.
Small sagebrush	Aplopappus bloomeri Gray.

FOREST LITTER.

On the eastern slopes the forests are generally open, travel off the trails being possible with pack animals, although sometimes difficult and slow. On the western slopes the forest litter makes travel on the trails or roads imperative, and the explorer or prospector must expect to carry his pack on his back and climb over or crawl under the fallen logs that cover the ground. Sometimes these logs are piled 20 feet high, as mute but eloquent reminders of an unusually heavy windstorm. In such areas logging becomes difficult and expensive, as it increases the proportion of "swampers" in the logging crew.

The litter is a menace to the forest, inasmuch as it is the best conductor for fire, and when logs are favorably placed a heavy downpour of rain will not extinguish the flames, which, surviving, proceed with the work of destruction.

HUMUS.

An important factor in the forest growth is the humus, which forms the upper soil everywhere, excepting where the fires have been so severe as to utterly destroy it. This loose deposit of fallen and decayed vegetation is most abundant in the heavy and unharmed forests, where it is from 3 inches to a foot in depth. As it is a retainer of moisture and a protector for the seedlings, the restocking of burned areas is a slow process if the humus has been totally destroyed.

A. FIR, MAPLE, AND ASH TREES

B. MOUNT HOOD; MOUNTAIN FIR IN FOREGROUND

On the steeper hillsides it acts as a retarding element to the surface drainage, preventing the sudden flooding of the streams during rains, and also preventing their entire cessation during the dry season. On the eastern slope, in the watershed of the Yakima River, the surface flow continues to feed the river for three months after the cessation of the winter rains and snows, and as the waters of this river are largely used for irrigation, the importance of the forest cover and the humus is easily seen. Lands are irrigated from April to October, inclusive, the largest demand for water generally being made in July, at which time at least one-half of the flow is from the melting snows. The time is rapidly approaching when the entire flow of this river will be utilized in the necessary and desirable conversion of deserts into gardens, and it is conservative to say that a fall of 1 foot in the river affects 300,000 acres of land.

FIRES.

EXTENT AND LOCATION OF BURNS.

The areas which may be classified as burns amount to 326,590 acres, or about 15¼ per cent of the total area of the reserve. Of this area about two-thirds are on the western side of the Cascade Mountains.

Ancient burns, of which traces still remain in the standing timber, cover probably 40 to 50 per cent of the area of the reserve, but being restocked with trees of large size, these areas can not be called burns. The fires of comparatively recent occurrence, whose effects may be studied and compared, have results depending upon the nature of the forest, the time of year, and the winds. A fire may clear the ground of brush, litter, and humus, but not materially damage the standing trees beyond charring them to a height of 10 or 15 feet. If more severe it may consume some of the standing trees without much regard to species or location, on account of the proximity of underbrush and litter to the bases of the trees destroyed. Such fires leave standing burned snags surrounded by green and unharmed old timber.

A "burn" results in the total destruction of all vegetation within the limits of the burned area, leaving only standing snags and stumps, and the ground covered with partly consumed logs. Small areas may be "clean burns" and show few signs of the former forest, but instead be a desert of burned sandy soil in which the traveler will sink ankle deep. The burns bear little relation either to topography or the kind of timber, their boundaries and extent having been determined by the initial fire and the direction of the wind. The smaller deciduous trees which have their habitat in the moist bottoms, such as alder and maples, are more immune than their coniferous associates, but even they do not always escape.

The great burns in the Cowlitz watershed occurred in 1841 and 1856, but portions of the area have been burned or reburned at intervals during the past ten years. Over large and irregular areas this region is restocked with the same species of trees which border it and probably constituted the original forest. In this restocking the noble fir (*Abies nobilis*) takes an important part, and, together with the other firs, would rapidly retimber this most unsightly region if fires could be prevented. On the Sawtooth Range a large fire occurred in 1896, and reliable witnesses say that one tree burned for six months.

The hills on the north side of the Cowlitz River have been burned over several times since settlement, the last burn being three years ago. In this and adjoining areas the second growth after the burn is very rapid.

From testimony of various Indians regarding the "big fire" it appears that it was of unusual severity. Many Indians and stock perished, and the few saved who were in its path were submerged in the river for protection. The heat was so intense as to kill some of the fish in the river.

The large burn on Bald Mountain occurred about 1860 and must have been a very severe and destructive fire, destroying all the vegetation and humus and exposing the thin scoria soil, which barely covers the eruptive rocks. Under such adverse conditions the process of restocking is necessarily slow, particularly as the seedlings must advance up hill unprotected.

The burn about Juniper Mountain and the head of McCoy Creek occurred in July, 1898. At about the same time a portion of the southwest slope of Mount Adams was burned, leaving an unsightly patch of dead snags which detracts from the beauty of the mountain view.

The recent burns near Steamboat Mountain and over scattered patches to the southward have occurred periodically during the past twenty years, the last and most extensive fire being in 1897.

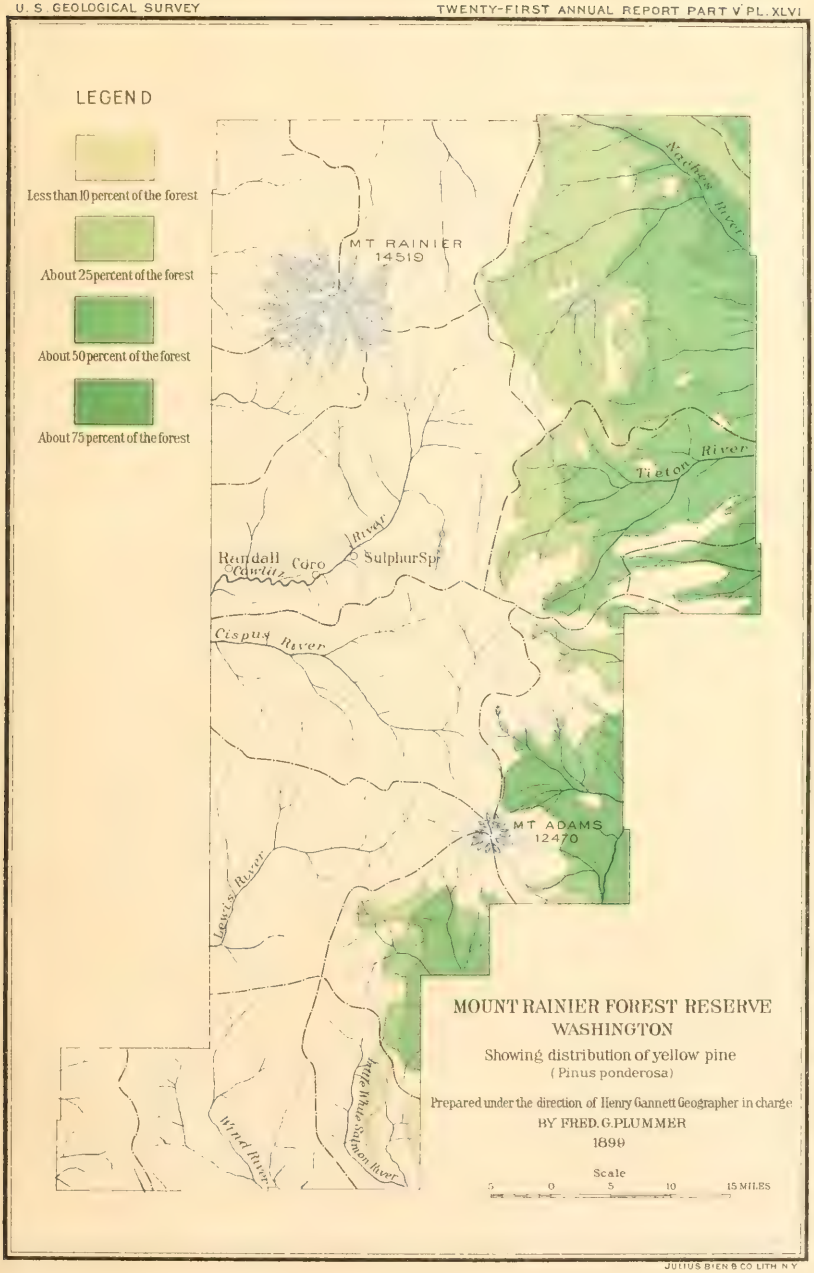
On the eastern slope of the Cascade Mountains the majority of the burns have occurred during the past decade, those of the Atanum and Tieton watersheds having mostly occurred since 1896.

A portion of the basin of Silver Creek was burned August 10, 1898, and at this time ashes fell at Longmires Springs, which is distant about 20 miles. Mineral Creek Basin, which is a tributary to American River, burned over in 1895.

CAUSES OF FIRES.

The fires which have occurred in the reserve may be traced to the following causes:

Campers and packers build their fires against logs or trees and neglect to extinguish them. Small fires that are built in the open do



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not spread unless the humus is deep and dry. They will smolder until fanned into flame by the wind.

Sheep men start fires to promote the growth of grass near the summits, believing that the destruction of the timber is generally followed by a growth of those grasses upon which sheep will feed. Severe fires also have the effect of clearing the ground of underbrush and litter and make it easier and safer to drive sheep from point to point.

Prospectors fire the timber with the object of clearing the ground to make prospecting easier. A great many miners are strongly opposed to this method as it gives a very dirty area to work in and the legitimate miner needs the timber for his shafts and tunnels.

Settlers start fires for the purpose of clearing the land for cultivation. As the settlers do not like to go to the trouble of carrying their brush or slashed timber away from the standing timber, they burn it where it falls in slashing.

Indians also start fires on the slopes and summits for the purpose of promoting the growth of huckleberries, blackberries, and raspberries, and also to drive game.

Camping parties often set fire to the resinous trees simply for the the pleasure of seeing them burn. Cases of this kind were not uncommon, but of recent years sentiment has been so strongly against this practice that the evil has almost ceased to exist.

Lightning also starts fires.

Since the inauguration of the present forest policy the causes may be briefly stated as ignorance, carelessness, and lightning. The expert woodsman, trapper, hunter, or camper for pleasure is careful about his fires and knows how to build them so that they will not spread and burn his tent and outfit. His cooking fire is never larger than necessary to hold a coffee pot, kettle, and skillet, and is usually made between two rows of rocks or two small green or wet logs. The fire will measure 8 by 20 or 30 inches, and within a half hour from the time of starting every small twig and dry cone in its immediate vicinity has been used for fuel and to safeguard against burnt shoes or trousers. The tenderfoot, on the contrary, builds his fires large and open, and the chance of their spreading is much increased if they are against logs or trees.

The fixing of a cause for any stated fire is almost impossible, unless lightning was the cause. Sheep men, prospectors, hunters, and ranchers accuse one another promiscuously, but no reliable data are obtainable. In the case of lightning, where the agency of a human being is not involved, some data have been collected and will be here given at the risk of giving that agent more prominence than might be justified were the other causes capable of the same investigation. These well-authenticated instances do, however, prove that lightning can not be omitted from the list of causes, although it may be argued that during

an electric storm the precipitation should be so great as to prevent a large fire from catching or spreading.

In May, 1897, lightning struck the timber in Cowlitz Bottom near the town of Vance on several occasions, the largest burn resulting in the destruction of about three acres of timber. In June, 1896, it struck the hills in secs. 1 and 2, T. 12 N., R. 7 E., and a large forest fire in the second growth resulted.

Timber on Juniper Mountain was struck by lightning in July, 1898, and a large burn resulted which destroyed considerable fair timber.

In the basin of the South Fork of the Rattlesnake on July 22, 1898, at 7.30 p. m., lightning struck a tree and also killed three horses belonging to Joseph Melini. Another stroke set a small fire which burned for ten or fifteen minutes. Both fires were extinguished by the accompanying downpour of rain.

On August 10, 1898, lightning struck several trees in Silver Creek Basin and a large burn resulted. There was no rain that day, nor was there at Longmires Springs, distant 20 miles, although the day was heavily clouded.

Two fires were started by lightning on July 28, 1899, in sec. 36, T. 7 N., R. 9 E., but did not spread beyond the trees struck.

RESTOCKING OF BURNED AREAS.

All of the restocking of the reserve is natural. No work has been done by man toward reseeding with the best species nor eliminating from young second growths the undesirable species. All of the activity thus far has been toward protection against fire, which may in a day destroy what would balance the work of years.

The process of reseeding is rapid. All of the timber trees seed abundantly and at a season when the high winds may distribute the seeds over large areas. It is doubtful if any assistance from man would noticeably affect the progress of this reseeding, which, if conditions of soil permit, results in a thicket of small growth in spite of the numerous animals which destroy seeds. In cases where a fire was not severe and representatives of one or more hardy species withstood the flames, the restocking begins from these survivors, which are not always the best timber species. The mountain hemlock (*Tsuga pattoniana*) seems to resist fire more successfully than the other species common in the alpine zone, and the tamarack (*Larix occidentalis*) survives best in the middle zone. In Naches Valley above the junction of Bumping River there is a very old burn. A few yellow pine and red fir of the old forest are still standing, and the heavy second growth is of the same species, with the addition of tamarack. Very small recent fires in the same area have injured many of the trees and made clean burns in some locations. From Naches Pass just outside the reserve for 5 miles down the river and into the reserve there is an

A. MOUNT RAINIER FROM GOAT MOUNTAIN.

B. BURN, WITH SECOND GROWTH.

old burn about 2 miles wide, which is now partly second growth white fir and tamarack, with willows along the banks. In the watershed of Atanum River there are indications that the tamarack stood the fires of an ancient burn better than other species.

After a clean burn the restocking must proceed from the bordering forests, and it is observed that although these bounding forests may be mixed, one species often predominates in the new growth. This fact may be accounted for by assuming that a favorable wind prevailed when that particular species was in mature fruit, and that the soil conditions in the burn were such as to give encouragement to that species. In this respect the tamarack easily takes the lead in eastern Washington, and the hemlock (*Tsuga mertensiana*) in western Washington. Of all the conifers these two species have the lightest cones and seeds, and are most exempt from the attacks of squirrels and chipmunks. These are among the least valuable of the timber trees, and it happens that the best of the pines, the white pine (*P. monticola*), and the best of the firs, the noble fir (*A. nobilis*), have large and heavy cones, and being subject to these depredations are checked in their efforts at restocking.

The grazing of sheep and other stock upon burned areas certainly retards their restocking with timber. If stock pasturing were prohibited upon all burned and low timberless areas until the restocking had resulted in such sufficient stand and age of timber trees that further protection would be unnecessary, it would remove a serious enemy from the field, and in all probability would result in extinguishing forest fires in their incipiency.

TIMBERLESS AREAS.

There is no altitude which may be termed a timber limit. This results from the fact that the bold topography of the reserve and the presence of numerous perpetual snow fields and glaciers cause different climatic conditions to obtain in areas not widely separated. Upon the slopes of Mount Rainier the alpine trees cover the sharp ridges to an elevation of 7,200 feet, and above this only a few scattering procumbent individuals find shelter behind some rock or crag. The extreme altitude there reached by trees may be stated at 7,600 feet, but at Goat Peak the same forms reach an altitude of 8,400 feet. The difference of latitude favoring Goat Peak is only a third of a degree, but the local climatic conditions are quite different. At lower elevations than these, however, many rocky peaks are often too exposed to permit a growth of trees or the accumulation of a scanty soil, excepting in the rock crevices where the hardy little alpine flowers will find strong root hold.

Cliffs at all altitudes are often too steep and smooth to permit the spread of the timber which struggles for existence on the talus slopes

below. Often the talus slopes are timberless, particularly when recent or when composed of fine chips, but in the majority of cases the pines and firs manage to advance over these uninviting areas.

Upon the slopes of Mount Rainier the glaciers flow to the lower altitudinal limit of 3,300 feet, and these areas are of course timberless, as are the perpetual snow fields which border the glaciers or lie upon the ridges which form the divides between the "cradles" of the glaciers.

The great timberless area of eastern Washington, or the "arid region," does not extend to the boundary of the reserve, but approaches it so closely that it is germane to the subject.

It appears to the most casual observer that the trees of the lower mountain slopes are forcing their way over these arid regions. A similar phenomenon has long been observed on the beautiful parked prairies of western Washington near Tacoma, where the advance of the red firs (*Pseudotsuga taxifolia*) has been as great as 25 feet per year. On the eastern slopes of the Cascade Mountains it is the yellow pine (*Pinus ponderosa*) that takes the lead among the conifers in attacking these arid regions. The red fir follows closely, seldom being more than 2 miles behind, and is in turn closely followed by the tamarack (*Larix occidentalis*). Other species follow rapidly, depending upon topography and soil.

TIMBER CUTTING IN THE RESERVE.

A total area of about 8,000 acres has been cut within the boundaries of the reserve. Of this amount 40 per cent has been cut by actual settlers and the balance by loggers.

The largest area is along Tieton River, from the reserve boundary westward. The lumber is reported as used for fluming and other construction work on the Selah irrigating canal. The cordwood from the same area was marketed in North Yakima.

At Tannum Lake about 200 logs have been cut and dressed on two sides ready for the construction of an impounding dam at the foot of the lake. This work was done in 1891 under the direction of the Yakima Investment Company, and most of the logs have been piled up at the point of proposed construction. Tannum Lake and Lakes Kitchelos, Katchess, and Clealum, which lie outside of the reserve, have been considered in connection with the extensive plans for the irrigation of the fertile slopes of the Lower Yakima Basin, which plans have been partly carried to completion. There is little doubt that they will be needed for storage in the future, as the nature of the Yakima watershed causes extremes of high and low stages in the river.

At the Medina mining camp on Silver Creek in Summit district, a small mill has been erected to furnish lumber to be used in the construction of a 5-stamp mill and the necessary fluming and buildings.

A. SUMMIT OF RANGE IN SOUTHERN PART OF THE RESERVE, LOOKING WEST.

B. HEADWATERS OF TIETON RIVER, FROM GOAT MOUNTAIN.

They have slashed an area of about 2 acres and cut a total of about 10,000 feet.

A sawmill in sec. 29, T. 15 N., R. 7 E., was run for a short time. The logging was largely from an area subsequently cleared and cultivated. There are about 10,000 feet of lumber in the mill yard.

A mill situated near Chenowith post-office in sec. 22, T. 4 N., R. 9 E., has cut a total of about 40 acres from patented land within the reserve. Another located in sec. 14, T. 3 N., R. 9 E., outside of the reserve, has cut about 160 acres.

A shingle mill is situated in sec. 20, T. 4 N., R. 9 E., and has a capacity of about 30,000 shingles per day. It cuts from patented lands.

In 1899 a small portable mill was located in sec. 8, T. 12 N., R. 7 E., but is now idle after filling a few small orders. The country tributary to it is patented and settled.

LOGGING CONDITIONS.

It may be said generally that the logging of those areas examined must be by skid and railroads. The only drivable stream is the Lower Cowlitz River, and as there is not much timber in its valley skids or trams will be needed to transfer logs from the timbered slopes of its watershed to the river. The exception to the above general statement is that during flood seasons several of the rivers carry enough water in confined channels to drive logs for short distances, and that shingle bolts, fence posts, and cordwood might be driven during the greater part of the year if drifts and other obstructions are removed. Such rivers are the White, Carbon, Little White Salmon, Cispus, Lewis, Wind, Puyallup, Nisqually, Klickitat, and Naches. With the present method of logging it is not likely that any of these streams will ever be used.

In all the watersheds the method and route of logging is fixed by the location of the main and secondary divides, which are usually sharp and well defined, without table-lands. In such cases the canyon slopes are so steep that log chutes might be used, but the areas tributary to such chutes are generally limited and contain little timber.

With the exception of a short narrow-gage railroad feeding the Oregon Mill Company's mill in T. 4 N., R. 9 E., there are no railroads in the reserve, nor are there any wagon roads over which heavy logs could be hauled. The Northern Pacific Railway Company has made a survey up the Nisqually Valley via Bear Prairie, down Skate Creek, up the Cowlitz and Summit Creek and over Carlton Pass in the Cascade Mountains, thence down Bumping River, but no construction work has been done. The Tacoma and Columbia River Railroad has made a preliminary survey from the end of their line at Lake Park, 11 miles from Tacoma. This survey runs up the Cispus River to Cispus Pass with the expressed intention of tapping a timber belt and certain coal prospects in the Cispus watershed.

SETTLEMENT AND IMPROVEMENTS.

Within the reserve there are 160 settlers, of whom about 75 per cent have made improvements other than the building of houses or cabins. From detail memoranda made during the examination the following figures are obtained:

Improvements in Mount Rainier Reserve, Washington

Number of houses (including trappers and prospectors)	181
Number of barns	90
Number of acres slashed	3,275.85
Number of acres cleared (mostly in pastures)	1,864.75
Number of acres in gardens	65.4
Number of acres in orchards	91.85

Generally the clearing of land for pasturage does not include the removal of large stumps, as this work is expensive, and in some locations would mean $150 per acre. The garden produce is for local consumption and is only limited by climate. The best results are from potatoes, onions, turnips, carrots, beets, parsnips, squash, and small fruits. Corn, tomatoes, and cucumbers are raised, but not to perfection. The orchards are principally of apples, plums, and pears.

GRAZING.

The grazing lands of the reserve are mainly upon the eastern slope of the Cascade Mountains, and have an area of about 800,000 acres.

During the season of 1899 approximately 260,000 sheep were herded on this area. The general method of herding sheep in the State of Washington is as follows: In the late fall and winter the sheep are pastured in the vicinity of their home ranches in the low lands and valleys of eastern Washington, and in severe weather feed on hay. In the early spring, after lambing and shearing, the bands are driven toward the mountains, reaching the reserve in June. They follow the receding snows to the very summits, grazing and browsing upon the new growth of grasses and deciduous vegetation. Late in August they commence to work down to the lower altitudes, and generally leave the reserve about the 1st of October.

As might be expected, there is a wide divergence of opinion regarding the advantages or disadvantages resulting from this practice, and the sheep owner's position has become one of active defense against public sentiment.

The arguments presented against the grazing of sheep in the reserve are as follows: (1) That the sheep men fire the forests for the purpose of promoting the growth of the forage plants. (2) That the sheep browse upon the young timber trees and trample out the seedlings. (3) That the removal of underbrush causes the streams to become more

A. MOUNT ADAMS.

B. CISPUS RANGE, FROM GOAT MOUNTAIN.

sensitive to melting snows, and the summer flow of rivers used for irrigation is thereby decreased. (4) That the sheep pollute the streams. (5) That the natural beauty of the reserve is partially destroyed.

The sheep owners and herders not only deny all the above, but claim in addition: (1) That the removal of the underbrush by the browsing of sheep lessens the liability of fires spreading. (2) That the herders are exterminating the bears, cougars, wildcats, wolves, and coyotes, which prey upon domestic animals.

There is little doubt but that sheep men have started fires, and that burns more or less extensive have resulted, but it is equally true that by reason of the strict regulations and enforcement of the law, together with a regard for their own interests, due to a wholesome fear of the cancellation of their permits, the practice has ceased, and any fires now originating with the sheep men are isolated cases resulting from carelessness.

Moreover, it is contended that setting fire to the timber does not necessarily result in the increase of the areas for pasturage. A clean burn more frequently results in a rank growth of huckleberries, and if the burn is not clean the ground remains covered with charred logs and snags, making travel slow and dangerous and the area often unfit for sheeping. The coarse grasses and weeds that immediately follow the fires are not the best forage, and it may be several years before they are succeeded by the better varieties.

It is a fact that the greatest number of burns and also those of the greatest extent are in portions of the reserve which have not been sheeped, and this fact has at least a general bearing on the subject, as these areas of great burns are on the western slopes and in the regions of greatest annual precipitation.

The claim that the sheep browse upon the young timber trees is not well founded so far as it relates to the conifers, and within the grazing area there are no deciduous trees of any value excepting the oak (*Quercus garryana*), and that is generally of a size only fit for fuel. Sheep, cattle, and horses will not eat foliage from the pines, firs, and other evergreens which comprise the timber of the reserve, unless driven to it by a hunger that is almost starvation. In the immediate vicinity of the separating corrals, where bands of sheep may be confined for one or two days during the process of separating, small evergreens were nipped by the sheep, and along the beaten and oversheeped trails the same thing may be noticed, but the damage is insignificant and only worthy of mention as an exception. During the examination our pack animals were several times in desperate need of pasturage, as our route of travel took us over miles of deep snow, which covered everything but the timber trees. These, however, the animals would not touch. On Pisco Ridge (outside the reserve), at an elevation of 6,000 feet, we found the remains of over 20 horses, which had perished in the snow,

huddled together in a bunch of young firs and pines. They had pawed the ground for grass roots, and had gnawed the bark from the trees and browsed on some of the foliage, but not to any extent.

There is no doubt that the sheep trample out seedlings of the conifers as they do of other trees and shrubs. Along the routes of sheep travel the forest floor is sometimes powdered by their sharp hoofs and all traces of undergrowth obliterated, and if this condition prevailed over a burned area the process of restocking would be very slow.

All of the conifers set cones in abundance, but not one seed in 100,000 produces a mature tree under ordinary conditions. Squirrels, chipmunks, and birds eat most of the seeds; forest shade kills many of the seedlings, and in the open it is a case of survival of the fittest. Inasmuch as a sufficient number of the seedlings generally survive to take part in the final competition and form the "thickets" so commons in the more open areas, it is evident that the enemies, including sheep, do not seriously affect the final result as stated.

The effect of underbrush and forest cover in retarding or accelerating the melting of snow is easily demonstrated by observation in the area of the Cascade Mountains examined. However, if it be assumed that the snow melts more quickly in the open many locations may be cited as evidence, and if the contrary be assumed the evidences are quite as numerous. This is for the general hypothesis, but there are details of exposure and altitude which enter into the problem and make it capable of solution. The masses of compact snow which are found in the open or timberless heights late in the summer are always upon hillsides protected from the warm chinook winds, and these are generally the northern and eastern slopes. Upon timbered mountains of equal altitude and where similar climatic conditions prevail the same slopes hold snow the longest. The effect of the underbrush and forest litter on the melting of snow is one which the traveler in these high altitudes is forced to observe for his own safety. It is only upon the hard snow which hides no brush or logs that safe footing is found. Wherever a log or brush exists the snow is soft and melting and the pack animals and men fall through, a matter of some consequence where the snow is over 6 feet deep.

Although the temperature in the forest may be slightly higher than in the open, for any given altitude, there can be no doubt that a stand of timber protects the snow from the warm winds and prevents the sudden rise of a stream. The underbrush does not give this protection, but is an agent in preventing the compacting and hastens the melting of the snow. To summarize: The snows will remain longest (other conditions equal) in—

(1) A forest without underbrush or litter.

(2) An open without brush or litter.

A. RECENT CINDER CONE ON NORTH SLOPE OF MOUNT ADAMS.

B. MOUNT ADAMS, WITH MOUNTAIN FIR IN FOREGROUND.

(3) A forest with underbrush or litter.

(4) An open with brush or litter.

The question of the pollution of the streams by sheep is one rather for the future than for the present, inasmuch as provision is made that the sheep "shall not be corralled within 500 yards of any running stream or living spring." If the corrals bordered on or had surface drainage into the streams the waters would be polluted in sentiment if not in fact when they reached the distant settlements, and sentiment is a strong factor when it applies to drinking water. One specification for good drinking water is that it must not contain more than one part by weight of dry organic matter in 100,000 parts of liquid, and it is safe to say that this limit is not exceeded in the river waters even in the immediate vicinity of the corrals. The fact that running waters are self-clarifying is generally conceded, although not to the extent set forth by Dr. H. Letheby, medical officer of health for the city of London, in relation to the Thames. His statement is that "sewage" when it is mixed with twenty times its volume of running water and has flowed a distance of 10 or 12 miles is absolutely destroyed; the agents of destruction being infusorial animals, aquatic plants and fish, and chemical oxidation. The question of pollution is therefore one to be considered in the precautionary way, and this has been done.

The scenery of the reserve is on too grand and extensive a scale to be affected by any operation of man, such as grazing or mining. The burns are the only disfigurement to the magnificent views which reward the climber of the peaks. Areas of particular beauty or novelty should be included in the National Park, on which pasturing is not allowed.

The Secretary of the Interior on June 30, 1897, promulgated rules and regulations relating to forest preservation, among which was the following: "13. The pasturing of live stock on the public lands in forest reservations will not be interfered with so long as it appears that injury is not being done to the forest growth and the rights of others are not thereby jeopardized." From my observations the injury done the forest growth by sheeping is not serious, and the attendant evils can be and are being guarded against.

MOUNT RAINIER FOREST RESERVE
WASHINGTON

SHOWING CLASSIFICATION OF LANDS

Prepared under the direction of Henry Gannett, Geographer in charge

BY FRED G PLUMMER

1899

Scale

MILES

Contour interval 500 feet

DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

THE

MOUNT RAINIER FOREST RESERVE, WASHINGTON

BY

FRED G. PLUMMER

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